BRITISH COLUMBIA DEPARTMENT OF MINES
HON. R. C. MACDONALD, *Minister*   JOHN F. WALKER, *Deputy Minister*

BULLETIN No. 27

GEOLOGY AND MINERAL DEPOSITS
OF THE
ZEBALLOS MINING CAMP
BRITISH COLUMBIA

By John S. Stevenson

1950

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Plate I-A. Mount Zeballos, east of the north fork of the Zeballos River; view taken from Privateer camp, looking northeasterly up valley of the Zeballos River.

Plate I-B. View up Spud Creek showing Privateer camp in foreground and Spud Valley camp in background; Mount Zeballos camp just around shoulder on right foreground; Goldvalley Creek next creek to Spud Creek on the left.

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ZEBALLOS MINING CAMP, BRITISH COLUMBIA.

CHAPTER I.—INTRODUCTION.

GENERAL STATEMENT.

This bulletin presents data obtained from a detailed study of the areal geology of the surface and of the extensive mine workings in the Zeballos camp and presents conclusions concerning the localization of ore in the camp. Conclusions of a general nature are given in the general discussion of ore deposits, and those of a more detailed nature relating to properties are given in the individual descriptions of the properties.

Early work was done by the writer in 1935, 1937, and 1938, and in 1938 by R. J. Maconachie, who also examined properties for the British Columbia Department of Mines. The results of these examinations were published in the Annual Reports of the British Columbia Minister of Mines for 1935 and 1938. The writer began systematic mapping and detailed study in 1941, spent three months in detailed mapping of underground workings in the winter of 1941–42, and, with one assistant, did areal work and further mapping of surface and underground workings for five weeks in 1944, three and one-half months in 1945, three weeks in 1946, and a week in June, 1949.

The only topographic map available, the Woss Lake sheet,* on a scale of 1 mile to the inch with 100-foot contours, had been compiled several years prior to the development of the area, from surveys made in 1931 by the British Columbia Topographic Surveys Branch. This map, with minor corrections to the drainage and with the addition of the roads, trails, mine workings, other cultural features, and of the boundaries of surveyed mineral claims, was used as the base for Figure 2. The roads and trails and the mine workings, excepting those of the Privateer, Spud Valley, and Central Zeballos mines, were surveyed by stadia and plane table or tape and compass. Company maps of the three mines mentioned were available to the writer.

ACKNOWLEDGMENTS.

The writer gratefully acknowledges the co-operation of residents in the area including those in the town of Zeballos and prospectors and operators at the various properties. The kind assistance of the various mining companies in providing full access to their maps, plans, and other information and in supplying office space was a great help to the writer in his work. Special thanks are due to Messrs. D. S. Tait, N. E. McConnell, C. H. Hewat, and W. Lammers, of Privateer Mine, Limited; Messrs. D. Pitt and W. Elliott, of Spud Valley Gold Mines, Limited; Messrs. O. C. Thompson, S. Ellis, and N. F. Brookes, of Central Zeballos Gold Mines, Limited; and Mr. W. S. Hamilton, of the Mount Zeballos mine. The writer also gladly acknowledges the help of his field assistants, James A. Teevan in 1944, John C. Amy in 1945, and John K. Diebel in 1946.

PREVIOUS GEOLOGICAL WORK.

Mention of activity on and short descriptions of the early properties in the district are made in the Annual Reports of the Minister of Mines for British Columbia, first in 1908, then in 1924, and fairly continuously thereafter. The first systematic geological study of the area was made by H. C. Gunning, who in 1932 mapped the principal geological formations and correlated them with similar formations to the north in the Quatsino Sound and Nimpkish Lake areas. Gunning's report and a geological map on a scale of 1½ miles to the inch covering an area of about 142 square miles were published in Summary Report of the Geological Survey of Canada for 1932. Work done by Gunning in adjacent areas at about the same time was published in 1938 in five preliminary geological maps: Nimpkish West Half, Nimpkish East Half, Woss Lake West Half, Woss Lake East Half, and Schoen Lake West Half, on a scale of 1 mile to one inch with 1,000-foot contours and with geology shown in pattern.

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* National Topographical Series, Sheet No. 92½, Woss Lake.

In 1935 M. F. Bancroft examined mineral deposits along the west coast of Vancouver Island between Esperanza Inlet and Alberni Canal for the Geological Survey of Canada and results were published in Memoir 204.

The maps and reports by Gunning and the reports by Bancroft are a continuing help to prospectors and engineers in the district, and the writer has consulted these references frequently.

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LOCATION AND ACCESS.

Zeballos, on the west coast of Vancouver Island (Fig. 1) about 190 nautical miles northwesterly from Victoria, is a logging and mining community that was founded as a result of a gold rush to that section of the island in 1935.

The Zeballos mining camp includes mainly the drainage area of the Zeballos River. The area in which the most important properties have been found lies in the angle between the main Zeballos River and the Nomash (South Fork) River and is bounded on the south by a line running east from Zeballos River at a point 1½ miles northerly from tidewater, an area which includes the valleys of Van Isle, Spud, and Goldvalley Creeks.

The Canadian Pacific Railway Company maintains a steamship service from Victoria and Port Alberni up the west coast, calling regularly at Zeballos. The service was formerly tri-monthly but is now every eight days from Victoria. In the spring of 1947 Gibson Brothers, Limited, started a twice-weekly service with a converted

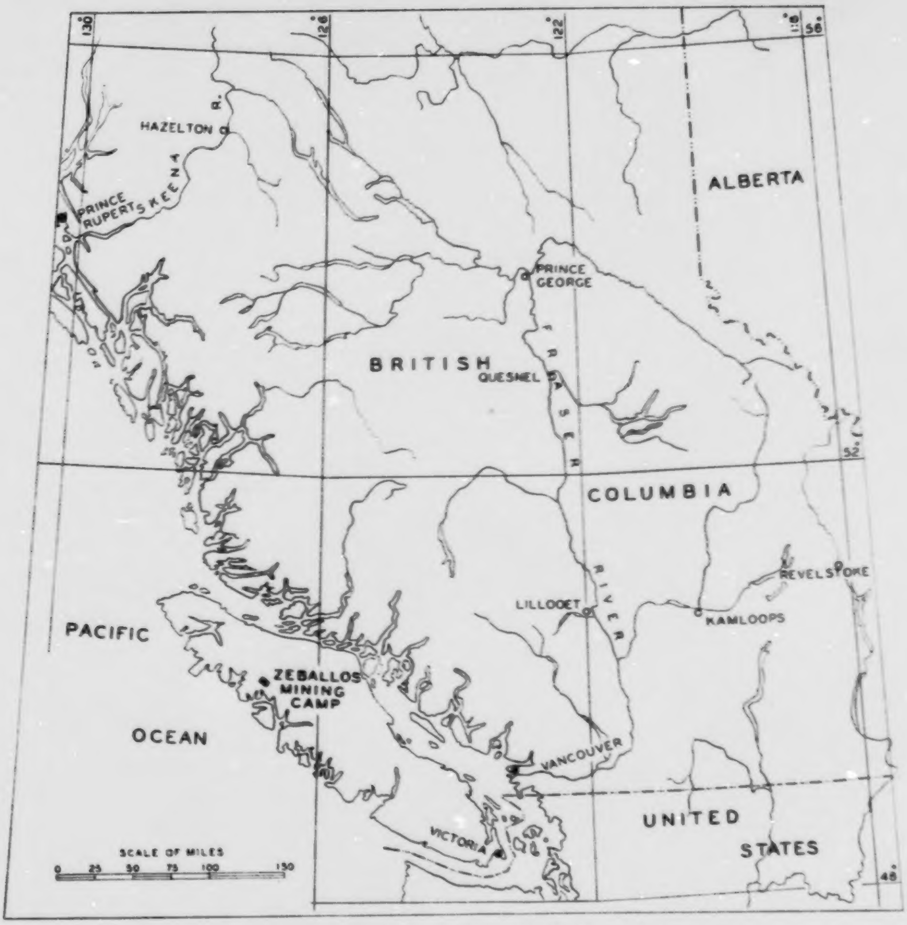
130°
126°
122°
118°
56°
52°
48°
HAZELTON
SKEENA R.
PRINCE RUPERT
ALBERTA
PRINCE GEORGE
BRITISH
QUESNEL
FRASER RIVER
COLUMBIA
REVELSTOKE
LILLOOET
KAMLOOPS
PACIFIC
ZEBALLOS MINING CAMP
OCEAN
VANCOUVER
UNITED STATES
VICTORIA
SCALE OF MILES
0 25 50 75 100 150

Fig. 1. Index map showing position of Zeballos mining camp.

Fairmile-type naval vessel from Port Alberni to Ceepeecee where motor-boats may be obtained for the remaining 12 miles to Zeballos. Queen Charlotte Airlines maintains a daily air service, excepting Sundays, from Vancouver to Zeballos. Motor taxi-service was operated on schedule in 1946 between the town of Zeballos and the mines, 4 to 6 miles away.

Access to the mines is by a motor-road that leads up the main river valley for 4 miles from Zeballos Post Office to Privateer mine and a further 1½ miles to Mount Zeballos and Spud Valley mines. From the Privateer a branch road runs for 2 miles to the Central Zeballos mine, and the road extends for about half a mile farther, beyond which a tractor-road 2¾ miles long leads to the Homeward mine. A tractor-road 1.2 miles long to the C.D. mine leaves the road between Privateer and Central Zeballos mines. A few pack-horse trails and several foot-trails lead to the various smaller properties and prospects in the area.

TOPOGRAPHY.

The country is mountainous and extremely rugged. The altitude within the area mapped (Fig. 2) ranges from about 75 feet above sea-level in the Zeballos River valley at the south edge of the area to 3,749 feet at the summit of Mount Lukwa towards the eastern edge of the area, and to 4,041 feet, the summit of an unnamed peak in the northwestern corner of the area. The gradient of the Zeballos River within the area is not great, averaging about 4½ feet per mile from the canyon to its junction with the Nomash, a distance of 4½ miles, but the grades of the creeks that join the river are very steep, ranging from 500 feet per mile in many of the creeks to cataracts and waterfalls in others. The creeks come into the main valley on moderately uniform grades without the abrupt changes at the edge of the main valley that are characteristic of hanging valleys.

As the hillsides are steep and bluffy, travelling, except along carefully chosen routes, is difficult. The heavy growth of timber on the hillsides hides numerous bluffs and makes the planning of routes of travel for geological traverses difficult. On downhill traverses one is likely to come to unsuspected and unscalable bluffs and be forced to make a detour, usually uphill, around the bluff. Many of the creeks flow down waterfalls in narrow canyons out of which it is impossible to climb, and it is often necessary to return down the creek and follow another route. The writer spaced his traverses as closely as the geology required, except in a few small areas where bluffs and canyons made traversing impossible.

The higher peaks within the area are barely above timberline and the area covered with alpine flora is therefore small. Most of the mountain tops and the higher hillsides are covered with yellow cedar and hemlock, the lower slopes with hemlock and balsam. The main valley of the Zeballos River has much Douglas fir and red cedar, some of which was logged in 1940–41, and the rest is being logged at present (1949). Except for a few small garden plots in open areas or on ground that has been cleared of timber and is sufficiently well exposed to the sun for plant growth, there is no arable land in Zeballos.

CLIMATE.

The climate is wet and mild. Records of precipitation, taken over a three-year period by the bank manager at Zeballos townsite, give the total precipitation as follows: 1939, 223.7 inches; 1940, 196.1 inches; and 1941, 205 inches. As the mines are at higher altitudes, the precipitation at them is considerably greater than that at the townsite. The total precipitation for the area in which the mining properties are found is probably between 230 and 240 inches in most years.* Total snowfall varies considerably from year to year. It is never more than a few inches at the beach but ranges in depth from 1 to 6 feet at Privateer and farther up Spud Creek is much deeper.

No records of temperature are available, but the temperature may be considered moderate. During the winter, frost is sufficiently severe at the mines to freeze exposed water pipes, but rarely the river. During the winter of 1946–47 the harbour at Zeballos had a thin sheet of ice on it for a short period, but this was the first time in the knowledge of local inhabitants that the harbour had frozen. The summers are mild and never exceedingly hot, the air usually being cooled by draughts down the main valleys. Mosquitoes and flies are generally fewer in Zeballos than in many parts of the Province.

MINING HISTORY.

Although small amounts of placer gold had been obtained from the Zeballos River as early as 1907, it was not until 1924 that the first gold vein was staked on the Tagore property. Two years later the King Midas was staked, and by 1929 forty claims had been staked in the valley. In that year the first shipment of ore was made. It consisted of 2 tons of high-grade ore mined from the Tagore.

A period of inactivity followed until 1934, when the first of the rich gold-quartz veins that were to make the Zeballos camp an important producer in a very short time was found. Small pockets of coarse placer gold had been found earlier under the large boulders at the mouth of Spud Creek and in the autumn of 1933 rich gold-quartz float had been found near the mouth of the creek. The float was followed upstream and the rocky beds of the steep creeks coming into Spud Creek were searched. Early in 1934 the veins on the White Star property were found. In 1935 the Goldfield vein on the Spud Valley property was found, and in 1936 the No. 1 vein on the Privateer. Prospecting activity followed quickly, and other veins were found, not only near Spud Creek, but also on other creeks draining into the Zeballos River. During the early days of the camp, high-grade ore was taken in Indian dugouts down the river at times of high water from the mouth of Spud Creek to the head of the canyon about 1 mile from the sea and then back-packed to the beach.

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* Based on a discussion with an official of the Water Rights Branch, British Columbia Department of Lands and Forests, and on the records for Zeballos townsite.

Mining really began in the winter of 1934–35 when high-grade ore was shipped from the property of White Star Gold Mines. In 1937 shipments of high-grade ore were made from No. 1 vein on the Privateer. In 1938 the Privateer mill and Spud Valley Gold Mines mill began operating. That year nearly 400 men were employed at thirty properties in prospecting, development work, and production. In 1939 mills were built at the Mount Zeballos and Central Zeballos mines, and in 1941 a mill was built at the Homeward. About the middle of 1942, the shortage of men and supplies because of World War II forced all but the Privateer and the Prident to close, and in October, 1943, these properties also were forced to close. During the winter of 1945–46, operations were resumed at Privateer, Prident, Central Zeballos, and Spud Valley mines, but owing to the increasing cost of supplies and labour relative to the fixed price of gold, these mines were forced to close again and by the end of 1948 Privateer, the last to operate, had ceased operations.

PRODUCTION.

A summary of the gold produced in the Zeballos camp is given in the table on page 15. This table gives the number of ounces of gold produced each year at individual mines, the total for each mine, and the production in each year for the whole camp.

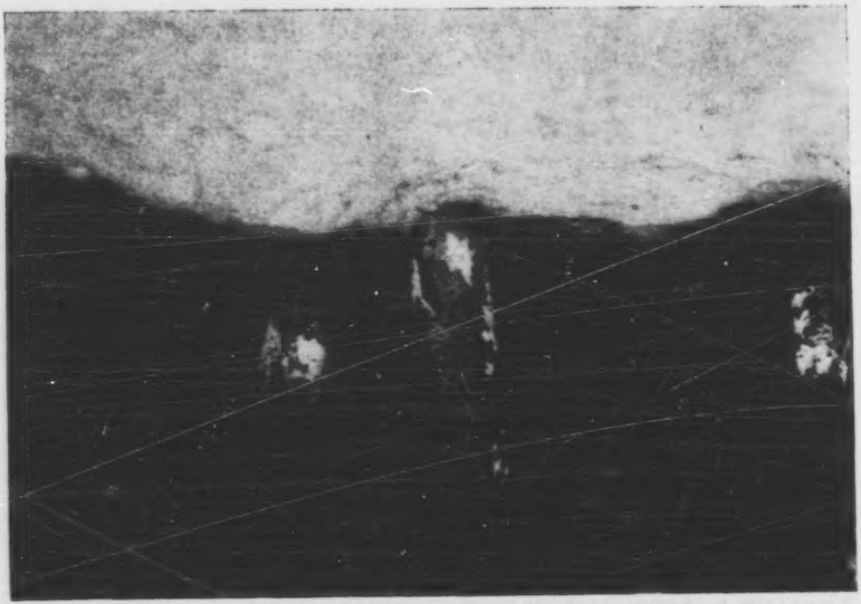

Plate II. Shrinkage stope, about 2½ feet wide, on No. 2 vein, 1100 level, Privateer mine, looking up from floor of level.

The total production of gold amounts to 287,811 ounces and the total silver to 124,700 ounces. The total quantity of ore mined in the camp amounted to approximately 651,000 tons. The quantity milled amounted to approximately 370,750 tons and the remainder, except for a small quantity of crude ore shipped to the smelter, was sorted out as waste. The over-all grade for the camp was approximately 0.44 ounce of gold per ton mined; or, based on a yield of 280,623 ounces from the ore milled, an average of 0.75 ounce of gold per ton milled.

The over-all grade of 0.44 ounce of gold per ton mined is not truly representative of the Zeballos ore because the vein matter prior to dilution in mining was much higher than this. The veins were much narrower than the usual stoping widths and in places were accompanied by highly sheared wallrock. Both cut-and-fill and shrinkage methods were used in stoping (Plate II). With the latter it was necessary to mine a considerable tonnage of waste rock with the vein matter, which reduced the grade of ore. It should also be noted that at Privateer, the largest producer and responsible for nearly half the total production of the camp, the average grade based on a total production of 154,381 ounces of gold from 285,771 tons mined and 153,332 tons milled was 0.54 ounce of gold per ton mined and 1.01 ounces of gold per ton milled.

Most of the gold ores in the Zeballos camp contain the lead sulphide, galena. The lead content of mine-run ore generally was less than 1 per cent. and much of the lead was not recovered in milling. Except for the shipments from the King Midas and the Golden Gate properties, the raw ore and concentrates shipped to the Tacoma smelter from the Zeballos camp usually contained some lead. However, as the shipments were all made to a copper smelter, no payment was made for the lead.

Zeballos Gold Production, 1934 to 1948.[*]

	1934.	1935.	1936.	1937.	1938.	1939.	1940.	1941.	1942.	1943.	1944.	1945.	1946.	1947.	1948.	Total.
	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.
Privateer	85	55	58	2,805	16,023	32,987	28,416	24,328	17,219	9,727	22	....	1,801	10,822	10,033	154,381
Spud Valley (including Big Star)	....	....	47	....	473	15,369	18,099	14,031	6,020	....	....	....	....	....	....	54,039
Mount Zeballos	....	....	....	....	....	3,277	14,716	9,744	2,665	123	....	....	....	....	....	30,525
Central Zeballos	....	....	....	....	152	33	6,610	6,568	4,610	....	....	....	872	1,627	....	20,472
Prident	....	....	....	....	....	....	....	3,803	5,141	3,758	....	....	....	687	548	13,937
White Star	....	32	150	359	42	2,122	2,345	1,531	500	....	....	....	....	....	....	7,081
C.D. (Rey Oro)	....	....	....	....	1,102	843	1,319	1,336	....	....	....	....	....	....	....	4,600
Homeward	....	....	....	....	....	....	....	897	594	....	....	....	....	....	....	1,491
Van Isle	....	....	....	....	....	....	1,178	....	....	....	....	....	....	....	....	1,178
Rimy	....	....	....	....	44	....	....	....	....	....	....	....	....	....	....	44
Tagore	....	....	....	....	....	8	....	....	....	....	....	....	....	....	....	38†
Golden Portal	....	....	....	....	....	8	12	....	....	....	....	....	....	....	....	20
King Midas	....	....	....	....	....	....	5	....	....	....	....	....	....	....	....	5
Totals	85	87	255	3,164	17,836	54,647	72,700	62,238	36,749	13,608	22	....	2,673	13,136	10,581	287,311

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[*] Data in part from Yearly Summary Reviews of the Gold Mining Industry in Canada, published by Dominion Bureau of Statistics, Ottawa, and in part from British Columbia Bureau of Economics and Statistics and Department of Mines.

† Includes 30 oz. produced in 1930 and 1932.

CHAPTER II.—GENERAL GEOLOGY.

This report records a detailed study of one mining camp within a relatively small area. It is concerned with local rather than regional problems, and no attempt at regional correlation of the rocks has been made. The lithology of the rocks rather than their age is used as the basis for mapping. However, Gunning (1932, pp. 33–35) has correlated the volcanic and sedimentary rocks in the area with Mesozoic volcanics and sediments of the Vancouver group in the Nimpkish Lake region and, as in the Nimpkish area, has made a threefold subdivision of the rocks into a lower group, the Karmutsen volcanics; a middle division, the Quatsino limestone; and an upper group, of volcanics and minor sediments, the Bonanza formation. He has correlated the intrusives with the Coast intrusives of probable late Jurassic age.

The volcanics and sedimentary rocks comprise a conformable series that strikes, in general, northerly to northwesterly and dips westward to southwestward. Consequently, the oldest rocks are found to the east and the youngest to the west.

Andesitic lava, the oldest formation and belonging to the Karmutsen volcanics, is in the north central part of the mapped area. Massive limestone of the Quatsino formation overlies the lava to the west and is found adjacent to the andesite on the west. A large assemblage of volcanics, mainly pyroclastics with minor flows and comprising in part the Bonanza formation, overlies the limestone conformably to the west and outcrops over the southwesterly third of the mapped area. All these rocks are invaded by a northwesterly trending belt of Coast intrusives that include, from oldest to youngest, gabbro and hornblende diorite, granodiorite, quartz diorite, and several varieties of dykes. As this belt of intrusives occupies about half the mapped area, it is the predominant feature of the geology of the camp, and as the mineral deposits of the camp are associated with this belt of intrusives, it is of considerable economic and geological interest.

ANDESITE LAVA.

(A, Fig. 2.*)

Green volcanic rocks, mainly flow rocks, extend westerly from the north fork of the Zeballos River for a width of 2,000 feet and northerly from the Central Zeballos mine to the north edge of the area mapped. In most places within the area it was impossible to distinguish and measure the thickness of individual flows; however, on the Goldspring property, well-defined zones of amygdaloidal lava indicate flows that range in thickness from 5 to 10 feet. The flow rocks westerly from the north fork of the Zeballos River are separated from limestone on the east by a fault and conformably underlie limestone on the west along Contact Creek.

The rocks are dark green, massive, fine grained, and largely amygdaloidal. Under the microscope they are seen to consist of intergrown crystals of hornblende and andesine, the hornblende being more abundant than the andesine. Alteration of the rocks has been slight and has involved the formation of actinolite from the hornblende, and of a little epidote, chlorite, and carbonate from both the hornblende and plagioclase. The amygdules consist wholly of quartz or wholly of epidote. The quartz shows some mortar structure, the result of minor deformation of the lava. Gunning (1932, Fig. 4) has correlated these rocks with the Karmutsen formation.

LIMESTONE.

(B, Fig. 2.)

Limestone of the Quatsino formation overlies the andesite lava of the Karmutsen volcanics. The principal areas of limestone are on the northeastern side of the belt of intrusive rocks. The largest area is northwest of the Zeballos River and west of the north fork of the Zeballos River and extends northerly beyond the north edge of the map-area. Limestone outcrops in the bed of and along the east bank of the north fork of the river. The writer did not extend his mapping east of the river, but Gunning (1932, Fig. 4) shows limestone extending a considerable distance in this direction. Two smaller, easterly trending areas of limestone outcrop north and south of the Central Zeballos mine. Of these two belts, it is probable that only the northern, wider, and more homogeneous belt may be correlated with the principal areas of limestone northerly across the river. Gunning (1932, p. 33 and Fig. 4) has correlated the limestone north and south of the river with the Quatsino formation.

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* *See Figure 2 in pocket.*

The limestone in all these areas is medium to coarsely crystalline and, owing to extensive recrystallization, has lost all evidence of bedding. On weathered surfaces the limestone is grey, but on freshly broken surfaces it ranges from white to cream. The 900 crosscut on the Central Zeballos property, driven through 1,100 feet of this limestone, provides in its remarkably clean walls a wide section of fresh limestone for study. In this crosscut both grey and white types of limestone occur and, although intermingled, are distinct and easily recognizable. Selected typical analyses are tabulated on page 18 and analyses of samples taken at regular intervals across the limestone in the 900-foot crosscut are tabulated on pages 47 to 48. The analyses show that the grey limestone is normal calcium limestone,[*] but the white limestone is a high magnesia limestone ranging from magnesian[*] to dolomitic[*] limestone. Based on microscopic evidence both in thin sections and by index determinations of mineral grains in index liquids, the magnesian or dolomitic limestone was found to consist principally of the mineral dolomite,[†] with a little interstitial calcite. No brucite[‡] was seen in thin section, nor could any be seen on sawn or ground surfaces of high magnesia limestone etched by the procedure recommended by Goudge.[§]

The dolomitic limestone occurs as streaks of white crystalline rock that thicken and thin and range in thickness from a few inches to several tens of feet. The widest section of almost pure white, crystalline limestone, that is dolomitic limestone, seen in the 900 crosscut in the Central Zeballos mine measured approximately 70 feet along the crosscut. In detail, " veins " or bands of the white dolomitic limestone brecciate and surround isolated patches of the grey calcium limestone. These features suggest that the dolomitic limestone has formed by replacement or dolomitization of the grey calcium limestone, which was the original sedimentary rock type. It may be that the dolomitization was effected by hydrothermal solutions emanating from granitic bodies or from the deep-seated source of the granitic bodies found in the same area.

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[*] The classification of limestones used follows those of Goudge, M. F. (Limestones of Canada—Mines Branch, Dept. of Mines, Ottawa), and Mathews, W. H. (Calcareous Deposits of the Georgia Strait Area—British Columbia Dept. of Mines), and is applicable to rocks composed essentially of calcium carbonate with a lesser percentage of magnesium carbonate and generally containing not more than about 5 per cent. of other minerals. A rock falling within any of the following classifications may be considered as made up essentially of calcium carbonate and of magnesium carbonate within the range stated below. For convenience in comparing analyses, the ranges for magnesium carbonate ($MgCO_3$) and the equivalent magnesia (MgO) are stated. To be within a class, the $MgCO_3$ or MgO content must be greater than the stated minimum.

Calcium limestone: $MgCO_3$, 5+ to 10 per cent.; MgO, 0.96+ to 4.79 per cent.
Magnesian limestone: $MgCO_3$, 10+ to 40 per cent.; MgO, 4.79+ to 19.15 per cent.
Dolomitic limestone: $MgCO_3$, 40+ to 45.65 per cent.; MgO, 19.15+ to 21.85 per cent., 21.86 per cent. being the percentage of MgO in the pure mineral dolomite.

[†] The mineral *dolomite* is calcium-magnesium carbonate ($CaCO_3.MgCO_3$) and contains 21.86 per cent. magnesia (MgO).

[‡] The mineral *brucite* is magnesium hydroxide ($Mg(OH)_2$) and contains 69.1 per cent. magnesia (MgO).

[§] Goudge, M. F.: Magnesia from Canadian brucite, *Can. Inst. Min. Met.*, Trans., Vol. XLIII, pp. 484–485, 1940.

Analyses of Limestone.

	1.	2.	3.	4.	5.	6.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
MgO	19.80	1.65	0.27	17.18	0.85	2.43
CaO	32.70	53.70	52.46	35.01	54.36	51.73
R_2O_3*	0.05	0.06	0.58	0.78	0.28	0.30
Insol.†	1.10	1.03	5.18	0.94	0.88	2.10

1. White, crystalline dolomitic limestone, 900 crosscut, Central Zeballos mine (see p. 17).

2. Dark-grey, crystalline calcium limestone, 900 crosscut, Central Zeballos mine (see p. 17).

3. Grey calcium limestone outcrop, 200 feet southerly from Central Zeballos camp (cookery) (see p. 17).

4. Cream-coloured magnesian limestone in bed of Nomash River, 4,000 feet upstream from mouth of the north fork of the Zeballos River.

5. Grey calcium limestone, adjacent to No. 4, but downstream from it (see p. 17).

6. Mixed cream and grey limestone, adjacent to No. 5, but downstream from it (see p. 17).

* R_2O_3: Iron and aluminium oxides, with those oxides of titanium, zirconium, beryllium, chromium; five-valent phosphorus, arsenic, and vanadium. Usually for limestone R_2O_3 is essentially aluminium oxide, the remaining substances being present in very low percentages, if at all.

† Insol.: Acid insoluble material; contains those minerals, chiefly silicates, that do not dissolve when heated with hydrochloric acid.

Alteration of the limestone, in addition to recrystallization and dolomitization, includes the development of zones of garnet and diopside a few inches thick along nearly all the contacts of the limestone with the intrusive rocks. At some places, magnetite, pyrrhotite, and chalcopyrite have formed in addition to the garnet and diopside. Magnetite is found along the limestone contact north of the Churchill cabin, on the F.L. property, and on the Ridge claim. Chalcopyrite and some magnetite have formed in limestone near the diorite on the old Maquinna property along the contact of granodiorite and limestone 3,500 feet easterly from No. 2 adit of the Central Zeballos mine, and also on the contact of granodiorite and limestone 600 feet southerly from the upper adits on the same property.

PYROCLASTICS, LAVA, AND LIMESTONE.

DARK-GREEN ANDESITIC PYROCLASTICS AND LAVA.

(E, Fig. 2.)

Green volcanic rocks that are mainly pyroclastics underlie a northwesterly trending area 8,000 to 12,000 feet wide, which lies between the Privateer mine on the northeast and the Tagore mine on the southwest, and which extends for unknown distances northwesterly and southeasterly beyond the limits of the area mapped. A narrow belt of similar rocks a few feet to 1,300 feet wide extends from the Peerless property northwesterly to the F. L. property. Dark-green andesitic lava is found in several places interbedded with the tuffs and breccias. Gunning (1932, Fig. 4) has correlated these rocks with the Bonanza formation.

The pyroclastics, classified according to Wentworth and Williams,* range from fine crystal tuff that contains crystal fragments less than one-quarter millimetre (one one-hundredth of an inch) to coarse crystal tuff that contains fragments one-quarter to 4 millimetres, and from lapilli tuff that contains rock fragments from 4 to 32 millimetres (one-sixth to 1¼ inches) to typical volcanic breccia that contains rock fragments greater than 1¼ inches. Most of the rocks are coarse tuffs and lapilli tuffs. Volcanic breccias are found in some places and the fine tuffs in fewer places.

Fine Crystal Tuffs.—The fine crystal tuffs are well-bedded, clayey-weathering rocks, which under the microscope are seen to consist of a few small fragments of feldspar and quartz crystals in a fine, clayey matrix. The beds of fine tuff are usually a fraction of an inch thick, and the thickness of any one series of fine tuff beds is seldom more than a few inches.

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* Wentworth, C. K., and Williams, Howell: The classification and terminology of the pyroclastic rocks, National Research Council, Bull. No. 89, Report of the Commission on Sedimentation 1930–32, Washington, D.C., pp. 51–53, November, 1932.

Coarse Crystal Tuffs.—The coarse crystal tuffs are mainly massive, dark green, and noticeably granular. Under the microscope they are seen to consist mainly of broken crystals of andesine with lesser quantities of broken hornblende crystals. On weathered surfaces of those tuffs containing moderate amounts of hornblende, the hornblende, which is more resistant than the other constituents in the rock, stands out as prominent black crystals. This feature is well illustrated in outcrops of crystal tuff along the main road for 1,000 feet downhill from the Privateer bunk-houses.

Volcanic Breccias.—These are massive rocks, similar to the coarse tuff, but they are usually lighter green and on weathered surfaces show the outlines of rock fragments. In outcrops in stream beds, the breccia fragments weather out and give rise to a pitted surface, a feature that is well illustrated in outcrops in the Zeballos River beneath the Ford bridge. (Plate III.)

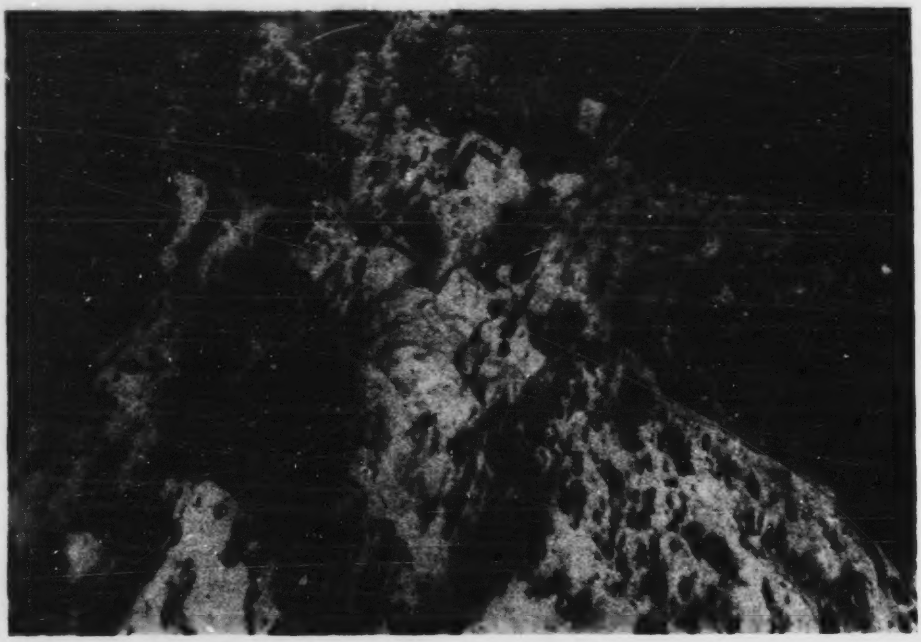

Plate III. Outcrop in bed of Zeballos River, beneath Ford bridge, showing pitting caused by erosion of fragments from slightly sheared volcanic breccia; beds dip to lower left.

The most abundant rock fragments are from a quarter of an inch to an inch long, but larger fragments, some a foot long, are common. A wide range in size and shape of fragments may be seen in the rock cuts on the High-line Road just southeasterly of the Van Isle mine. The corners of the fragments are slightly rounded and appear to have been abraded, possibly by water action, during the formation of the breccia. Most of the breccia fragments are andesite lava, but some are dacite lava, and the matrix is tuffaceous material, which consists of crystal fragments similar to those in the crystal tuffs.

Chemical analyses of dark-green crystal tuff, containing andesine, hornblende, and biotite are given in the table on page 20. The unusual feature of the analysis is the large content of alumina, which indicates an original content of shaly material in the tuff.

Analyses of Dark-green Andesitic Crystal Tuff and Lava.

	1.	2.	3.
	Per Cent.	Per Cent.	Per Cent.
SiO_2	46.74	52.00	50.82
Al_2O_3	19.29	20.43	15.49
Fe_2O_3	0.36	1.70	1.17
FeO	11.24	8.26	12.32
MgO	6.67	3.68	3.03
CaO	9.12	8.15	8.45
Na_2O	1.02	3.11	4.17
K_2O	2.54	0.48	0.72
H_2O-	0.15	0.20	0.05
H_2O+	2.12	1.24	0.86
TiO_2	0.34	0.11	1.88
P_2O_5	0.23	0.24	0.62
MnO	0.15	0.13	0.24
BaO	0.35	0.02	0.04
Totals	100.32	99.75	99.86

Analyst: G. C. B. Cave, Chemical Laboratory, British Columbia Department of Mines.

1. Crystal tuff from Privateer mine, 1100 adit, 125 feet from portal (p. 19).
2. Crystal tuff from outcrop on Privateer road, 500 feet northeast of turn-off to Central Zeballos mine (p. 19).
3. Lava from Mount Zeballos mine, face of 2000 level (see below).

Minor Andesite Flows.—Massive, fine-grained, dark-green andesitic lava, normally called greenstone, is found at several places interbedded with the tuffs and breccias. The largest area of lava is southwest of the Mount Zeballos mine where a band about 500 feet wide extends for an unknown distance northwesterly and southeasterly. Under the microscope this rock is seen to consist of felted laths of relatively unaltered plagioclase, fine, shreddy amphibole, and a small amount of biotite. The rock possesses an original diabasic texture and does not show any sign of recrystallization beyond the formation of shreddy amphibole or actinolite. Although much of the lava is without evident flow structures, some of it possesses amygdules and some aligned feldspar laths. It is on the basis of these features that the writer called the greenstone a lava.

A chemical analysis of typical, relatively unaltered andesite, given in column 3 of the table above, indicates that the chemical composition is that of a normal andesite.

Roof-pendant of Green Volcanics.—A northeasterly trending area of green volcanics a few feet to about a quarter of a mile wide extends from 1,500 feet southwest of the Peerless property northeasterly to the F.L. property. It is surrounded on the northwest and southeast by diorite and on the east by underlying limestone of the Quatsino formation. The rock is fine, even-grained, partly recrystallized andesitic lava and crystal tuff; the presence of occasional diopside-garnet layers suggests that some of the original rock had a high lime content. Along the contacts with the adjacent diorite, the volcanics are brecciated, and the fragments sealed by diorite. For a considerable distance from the contact the volcanics, even where unbrecciated, are spotted with indefinite patches of dioritic material.

This northeasterly trending area of volcanics is apparently a roof-pendant in the diorite lying across the general trend of the formations and was probably continuous with the green, fragmental volcanics that underlie much of the southwestern part of the area mapped.

LIMESTONE.*

Minor Limestone Areas.—Small areas of limestone, the more important of which are shown in Figure 2, occur in the volcanics southwesterly from the belt of intrusive rocks. The most extensive band of limestone, 50 to 300 feet thick, crosses Hidden

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* These areas and those of Quatsino limestone are designated by B in Figure 2.

Valley Creek just below the Prosperity adit; it appears to extend for 4,500 feet southeasterly to the Beano mine and may extend farther, as a similar band of limestone is found on Friend Creek, approximately 2,500 feet farther southwest beyond the south edge of the area.

This limestone is non-magnesian, and under the microscope it is seen to contain grains of quartz and plagioclase. Analyses of samples of this limestone from the 200-foot band in Waterfall Creek and the 100-foot band 600 feet southwesterly from Waterfall Creek are given in columns 1 and 2 respectively in the following table:—

Analyses of Limestone.

	1.	2.
	Per Cent.	Per Cent.
CaO	43.0	34.8
MgO	1.0	1.65
Insol.	16.0	30.3
Ig. Loss	34.1	29.6
R_2O_3	2.76	2.64
Total Fe	2.17	1.36
Total Mn	0.052	0.038
Total P_2O_5	0.07	0.07
Totals	99.152	100.458

Note.—R_2O_3 includes Al, Ti, Zr as oxides, but not Fe.

Analyst: G. C. B. Cave, Chemical Laboratory, British Columbia Department of Mines.

1. Calcium limestone on Waterfall Creek (*see* p. 20).
2. Calcium limestone 600 feet southwesterly from Waterfall Creek (*see* above).

LIME-SILICATE ROCKS AND LIGHT-COLOURED VOLCANICS.

Laminated light-green to white rocks form a belt 500 to 1,200 feet wide that extends from the Maquinna property southeasterly past the Privateer and Mount Zeballos mines and continues southerly and southeasterly to Sugar Loaf Mountain at the south edge of the area. The belt includes, in varying proportions, white lime-silicate rocks, light-green volcanics, principally tuffs, and gradational phases containing the two interbedded.

From the Privateer mine southerly to the south bank of Mount Zeballos Creek, the belt is composed principally of lime-silicate rocks with minor amounts of crystal tuff, but southerly from the creek to the Mount Zeballos mine, and continuing to the south edge of the sheet, the belt is composed principally of crystal tuff, in part shaly, with minor amounts of lime-silicate rock. At the Mount Zeballos mine and southerly, the belt of light-coloured rocks is divided into a western and an eastern belt by 100 to 300 feet of dark-green, fine-grained andesite lava. The western belt is absent between points 3,000 feet and 4,000 feet southeasterly from the Mount Zeballos mine but is continuous from the 4,000-foot point southeastward to the south edge of the sheet. The eastern belt, though narrower than the western belt, appears to maintain its continuity to the south edge of the sheet.

The dip in the northern part of the belt is nearly vertical, and the trend of the outcrop area corresponds to the strike regardless of the topography, but from the Mount Zeballos mine southerly the rocks dip 40 to 60 degrees southwestward and strike northwesterly, so that the trend of the outcrop area on the steep and irregular hillsides may depart considerably from the direction of strike.

Another belt of similar lime-silicate rocks a few feet to 1,000 feet wide extends for 9,000 feet southeasterly from the Central Zeballos mine to Curly Creek.

The writer believes that the rocks of the light-coloured belt that extends from near the old Maquinna property southeasterly across the river to the Privateer mine thence southerly and southeasterly to Sugar Loaf Mountain at the south edge of the area were deposited at essentially the same time. Towards the north, the rocks are dominantly shaly and calcareous, but are tuffaceous in part, and towards the south they are dominantly tuffaceous, but shaly and calcareous in part. This common, if variable, content of shaly and calcareous material distinguishes the rocks of this belt from the non-shaly, non-calcareous, dark-green pyroclastics and flows east and west of the belt.

LIME-SILICATE ROCKS.

(D, Fig. 2.)

The rocks in the northern part of the belt, from the Maquinna past the Privateer southerly to Mount Zeballos Creek and southeasterly from Central Zeballos mine, vary in shades of light grey, cream, and light green; they are mainly fine grained in texture and range from laminæ to layers several feet thick.

The rocks are composed of lime-silicate minerals, quartz, and a little biotite. The principal lime-silicate minerals are diopside, wollastonite, and plagioclase feldspar (labradorite to anorthite). Variations in the grain size and in relative abundance of these different minerals are reflected in the texture and colour of the rocks.

The light-grey, usually well-laminated rocks consist of layers about a thirty-second of an inch thick of fine-grained diopside, alternating with layers about a quarter of an inch thick of fine-grained but angular quartz. The cream-coloured rocks, some well laminated, some massive, but still layered in beds up to 1 inch thick, consist principally of closely packed grains of diopside with only a small amount of quartz. Anorthite that has recrystallized from less calcic plagioclase and abundant wollastonite are found with diopside in some bands of cream-coloured rock. The light-green rocks, usually massive, consist of abundant diopside and recrystallized anorthite; the diopside is coarser than in the grey and cream-coloured rocks and therefore imparts a definite greenish cast to the rock.

Smaller quantities of other rock types are found interbedded with the lime-silicate rocks. These include microscopically thin layers of closely packed, angular plagioclase crystals suggestive of crystal tuffs in the grey and cream-coloured rocks; beds 1 to 24 inches thick, which consist principally of pink lime-garnet, also in the grey and cream-coloured rocks; beds of fine-grained, but definitely brown tuff a foot to several feet thick bedded with the light-green rock. The brown tuff consists of angular plagioclase crystals surrounded by abundant recrystallized biotite, but does not contain any lime-silicate minerals.

Limestone beds 6 inches to 4 feet thick are interbedded with the lime-silicate rocks southeasterly from the Central Zeballos, but no limestone has been found in the Privateer belt.

The texture and mineralogy of the lime-silicate rocks in the northern part of the Privateer belt suggest that they originally consisted of calcareous, sandy shales with interbeds of crystal tuffs that were subsequently metamorphosed to lime-silicate rocks by the heat of intrusion of the nearby quartz diorite. The calcareous material in these rocks caused them to be more intensely altered than the adjacent volcanics, which were equally close to the quartz diorite but lacked calcareous matter.

The slight variations in amounts of lime, magnesia, alumina, and silica in the different beds of the original sediments and tuffs have been responsible for the variations in the relative amounts of the different minerals in the altered rocks. The cream-coloured sediments are the most abundant. They appear to have been calcareous, sandy shales with adequate amounts of lime, magnesia, alumina, and silica to form the minerals diopside, wollastonite, and plagioclase of which they are composed. Sandy and therefore siliceous sediments resulted in the grey rocks that are characterized by abundant quartz and minor amounts of diopside. Rocks high in both lime and silica were altered to rocks with abundant wollastonite but lesser amounts of the other minerals. Sediments more aluminous, and with a larger amount of original feldspar, but still somewhat calcareous and siliceous, appear to have been altered to the light-green rocks that are characterized by diopside and feldspar and some quartz. The most aluminous rocks, still calcareous, formed garnet-rich layers.

Beds of crystal tuff lacking the calcareous material of the sediments but containing plagioclase and hornblende recrystallized to biotite-rich rocks form the beds of brown rock interbedded with the sediments. The microscopically thin layers of fragmental plagioclase found in some of the laminated sediments appear to have been very thin layers of crystal tuff; hornblende or biotite, no doubt associated with the plagioclase, has combined with the lime of the adjacent sediments to form the lime silicate, diopside.

The lime-silicate rocks are cut by biotized dykes 1 to 20 feet wide that are similar in colour and grain size to the interbedded brown crystal tuffs but are different in texture. Although the biotized dykes are recognized megascopically as dykes only by their crosscutting relationship to the enclosing stratified sediments, under the microscope their diabasic texture, as opposed to the fragmental texture of the tuff, is apparent.

LIGHT-COLOURED VOLCANICS.

(C, Fig. 2.)

From the Mount Zeballos mine southeasterly to the edge of the area mapped, the light-coloured belt is composed largely of massive rocks but includes some layered rocks. In colour the rocks are light grey to brownish grey, or white to light-greenish white. They are principally crystal tuffs with minor flow rocks, and although largely non-calcareous they include occasional beds rich in diopside and garnet, which, because of the presence of these minerals, must originally have been somewhat calcareous. The rocks of this belt are exposed best in the workings of the Mount Zeballos mine and on the hillside southerly from the mine.

The light-grey to brownish rocks are andesite crystal tuffs but contain only a small amount of ferromagnesian minerals and hence lack the dark-green colour of the more typical andesite crystal tuffs that are rich in ferromagnesian minerals. To distinguish between the two rocks of andesitic composition, the writer has described the lighter-coloured, more unusual rock at the Mount Zeballos mine as feldspar crystal tuff. This tuff is characterized by feldspar grains a thirty-second to an eighth of an inch in size in a fine-grained matrix, which gives the rock a porphyritic appearance. Some of this crystal tuff appears so much like a porphyry that it might be called "feldspar porphyry" in the field. When examined carefully with a hand lens or studied under the microscope the grains are seen to be broken crystals; some are crystals with only a corner or two broken off, and some are merely small angular parts of the original crystals; all the fragments are embedded in a fine-grained matrix of finely tuffaceous or shaly material. In the light-grey variety of this tuff the feldspar grains are abundant and are closely packed with little interstitial shaly matrix. In the light-brownish variety, which is separated from the grey by 100 to 300 feet of dark-green andesite lava, the original feldspar crystals are widely scattered in a matrix that has largely recrystallized to equigranular, untwinned oligoclase, and contains quartz, some biotite, and conspicuous sheaves of sillimanite. The matrix of both varieties contains sillimanite, oligoclase, and some quartz, but the matrix of the light-grey variety is much finer grained than that of the brown rock. Under the influence of heat, the finely tuffaceous and aluminous material in these rocks would readily recrystallize to plagioclase, quartz, biotite, and to the highly aluminous mineral, sillimanite. Both rocks contain occasional small fragments of andesitic lava an eighth to a quarter of an inch in size, but as the constituent minerals of the lava fragments did not recrystallize along with the tuffaceous matrix, the fragments still possess their original diabasic texture. This feature and the fact that the andesitic lavas above and below the light-coloured tuffs did not undergo any recrystallization indicate either that the heat responsible for the recrystallization of the tuffs was insufficient for the recrystallization of the lava, or that the tuffs were more permeable than the lava to water, a necessary accessory in mineralogical changes.

The feldspar-rich grey rocks and the feldspar-poor brown rocks both appear to be recrystallized tuffs, composed originally of fragmented feldspar crystals in a fine-grained matrix. The brownish rock contains fewer large feldspar crystals and its matrix, though now coarsely recrystallized, appears to have contained more fine tuffaceous material than the matrix of the grey rock.

The brown, feldspar-poor tuff lacks fine lamination, but a frequent streakiness suggests former bedding planes, and the presence of layers of this tuff from 2 to 6 inches thick alternating with layers of white dacite tuff (*see* below) or with layers of garnet-diopside rock 2 inches thick also suggests bedding. The grey, feldspar-rich tuff also lacks fine lamination but is in beds from 2 to 160 feet thick, 40 to 160 feet being the common range of thickness.

A chemical analysis of typical, brownish, feldspar crystal tuff is given in column 1 of the table on page 25. The unusual feature of the analysis is the high content of alumina relative to the combined content of soda, lime, and potash. The presence of sillimanite probably accounts for the high alumina content and indicates an original high alumina or shaly content to the tuff.

Dacites closely associated with the feldspar crystal tuffs are dominantly of a striking white colour, but occasional patches are green. The dacites are generally massive and of a porcelainous texture. They consist principally of albite-oligoclase feldspar and quartz, and therefore have the composition of dacite (quartz andesite), but as the feldspar is more sodic than is usual in such rocks, they might be called sodic dacites.

Both dacite crystal tuffs and dacite lava flows have been recognized. The tuff beds range in thickness from 2 inches to 50 feet, and the lava flows usually from 15 to 50 feet. Frequently the thinner beds of dacite tuff are interbedded with feldspar crystal tuff in beds of similar thickness.

The dacite tuffs consist of conspicuous, fragmented crystals of albite-oligoclase feldspar and quartz in a fine-grained, but recrystallized, matrix of the same composition. The flows consist of phenocrysts of similar feldspar and quartz set in a medium-grained, felted groundmass of feldspar laths with interstitial quartz; the groundmass in the flows does not show any sign of recrystallization.

The dacite tuffs may be recognized by their bedding, fine grain, and closely jointed structure. Beds of white-green dacite tuff 2 to 6 inches thick, which alternate with brown andesite tuff in beds of similar or less thickness (Plate IV), may be seen at the Mount Zeballos mine in the adits on the Farris vein and in the 1600 and 1800 adits in the Mount Zeballos vein. In the more massive, white rock seen in these workings, bedding is inferred from faint, light-green streaks. In general, the beds of dacite tuff range in thickness from 10 to 50 feet.

Flows of dacite are interbedded with the tuffs. The flows range in thickness from 15 to 50 feet. Like the tuffs they are white to pale green, but they differ from the tuffs in that usually they are not banded and have a much coarser groundmass, in which the individual plagioclase crystals are easily recognized with a hand lens.

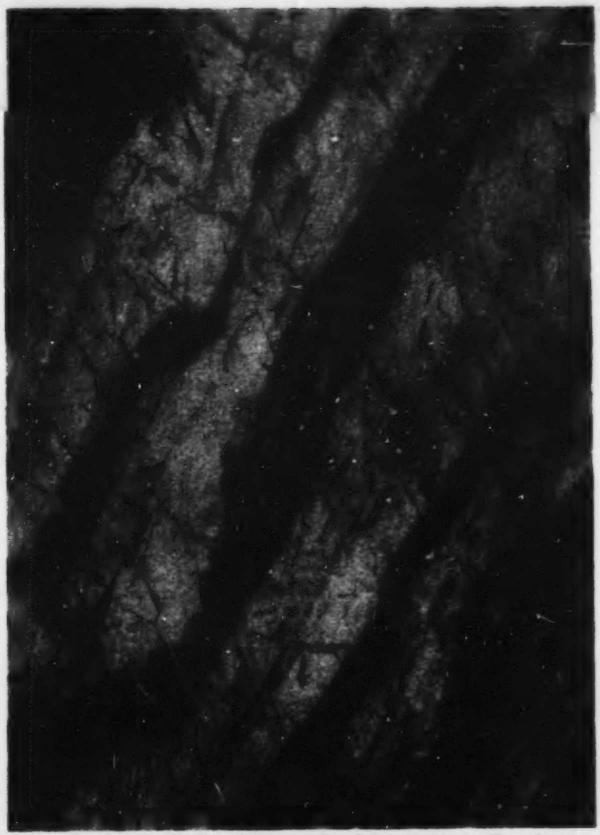

Plate IV. Beds of greenish-white dacite tuffs, about 6 inches wide, alternating with brown andesite tuff, Mount Zeballos mine, 1800 level on Farris vein; beds dip to lower left.

Analyses of Light-coloured, Feldspar Crystal Tuff and Dacite Tuffs.

	1.	2.
	Per Cent.	Per Cent.
SiO_2	66.98	71.41
Al_2O_3	14.72	15.03
Fe_2O_3	1.19	0.44
FeO	6.64	1.49
MgO	2.65	0.95
CaO	1.20	1.68
Na_2O	4.15	7.51
K_2O	0.40	0.32
H_2O-	0.22	0.08
H_2O+	0.98	0.32
TiO_2	0.80	0.58
P_2O_5	0.14	0.12
MnO	0.08	0.02
BaO	Trace	Trace
Totals	100.15	99.95

Analyst: G. C. B. Cave, Chemical Laboratory, British Columbia Department of Mines.

1. Feldspar crystal tuff, from Mount Zeballos mine, outcrop in creek 100 feet above Farris 1800 level (*see* p. 23).
2. Dacite tuff from Mount Zeballos mine, 1800 level (*see* p. 24).

Massive, white to pale green dacitic rocks are found within the area of dark-green pyroclastics outside the Privateer-Mount Zeballos band of light-coloured crystal tuffs and lime-silicate rocks. The individual outcrops are seldom more than 50 feet in diameter, and the white dacite can usually be traced only a few hundred feet along the prevailing northwesterly trend of the rocks. Outcrops have been found:—

- On the Maquinna property 300 feet west of the Burt adit and at the upper adits on the eastern branch of Maquinna Creek;
- At an elevation of 2,000 feet on a nose at the head of the western fork of Maquinna Creek;
- At three separate places on the eastern side of the Zeballos River valley about a mile north of Tagore mine and at the Tagore mine;
- In Hidden Valley Creek, downstream from the Prosperity adit, where a moderately continuous band of dacite tuff and lava about 250 feet wide trends southeasterly and is apparently continuous with a similar body at the upper open-cuts on the Beano property and possibly continuous with similar rock in Friend Creek, about 3,500 feet southeasterly from the Beano and beyond the southern edge of the area. The dacite in Hidden Valley Creek is partly interbedded with limestone and elsewhere in the creek contains occasional small lenses of limestone. The dacite at the Beano is definitely a tuff; angular fragments of quartz and feldspar may be seen under the microscope; recrystallization has been slight, and all gradations from only slightly broken to completely fragmented crystals of quartz and albite-oligoclase feldspar may be seen.

ROCK ALTERATION.

Apart from the general low-grade metamorphism that characterizes all the volcanic rocks of the area and results principally in the formation of chlorite, shreddy amphibole, epidote, zoisite, and calcite, a conspicuous, localized alteration characterized by patches of light apple-green, lime-silicate minerals is seen in the tuffs of the Privateer-Mount Zeballos belt and in volcanic breccia at the Mount Zeballos mine. The altered areas range in size from elliptical patches one-quarter of an inch long to cusp-shaped areas 6 inches long. An early stage in their formation may be seen in the light-green discoloration along joints in the tuffs. Mineralogically the light-green altered rock consists of a fine-grained intergrowth of quartz, diopside, epidote, andesine, and occasionally wollastonite. Streaks and patches of wollastonite are found within many of these apple-green patches but not outside them. It is probable that the tuffs and breccia were calcareous and shaly in part, and that the lime in them promoted the formation of the lime-silicate minerals during thermal metamorphism of the rocks.

Many of these apple-green patches contain kernels of pyrrhotite half an inch to 2 inches across, which suggests that the pyrrhotite is older than the apple-green alteration. In some places patches of pyrrhotite associated with apple-green alteration are up to 18 inches long.

The apple-green alteration with pyrrhotite is not necessarily adjacent to the quartz veins and is, therefore, probably not related to the quartz-vein mineralization. This type of alteration has been found along beds up to 100 feet from the vein in the Mount Zeballos mine; this distance being the farthest distance any crosscut has been driven from the vein. In this mine, both the pyrrhotite and patches of alteration have been cleanly cut by the vein shear. Apple-green alteration has spread out from joints in diabase dykes, which indicates that the alteration postdated the dykes.

In the Mount Zeballos mine, apple-green alteration is also found along the sheared contacts of the coarse crystal tuff and finer tuff where the patches are strung out up and down the dip and tend to coalesce. The same type of alteration was noted along the contact of the course tuff and of a 4-foot diabase dyke. Similarly, certain zones in the coarse tuff that have been slightly more fractured than the adjacent rock tend to be altered. It is apparent that relative permeability of zones or rock types was an important factor in determining the intensity of apple-green alteration.

An advanced stage of this alteration may be seen in the Privateer mine, where dark-brown volcanics, close to and within the wide band of lime-silicate rocks, are extensively altered to dense, light-green rocks that consist principally of diopside and plagioclase. The light-green alteration spreads from joints or fractures in the brown volcanics and produces streaks of light-green rock or, spreading out from centres along a joint, produces bulbous-shaped, light-green areas from a fraction of an inch to several feet in diameter. The light-green rock resulting from this traceable progressive alteration from joints is indistinguishable texturally and mineralogically from the light-green rock belonging to the band of lime-silicate rocks; therefore, one would conclude that the alteration of the brown volcanics to green diopside rocks was due to the action of calcareous solutions migrating from the adjacent, more calcareous sediments during the metamorphism of these rocks. The streaks and crescent-shaped patches of volcanics within the light-green sediments may represent unreplaced remnants of thin, dragfolded beds of volcanics in which replacement by calcareous solutions was more rapid and apparently more complete along the limbs than along the thick crests of the folds.

The apple-green alteration preceded the emplacement of the quartz diorite. Apple-green altered rock is cut by aplite stringers and is found as inclusions in unaltered quartz diorite; the alteration, therefore, is older than the aplite and the quartz diorite.

COAST INTRUSIVES.

A northwesterly trending belt of granitic rocks extends through the central part of the area and includes intrusive bodies that have been indirectly responsible for the mineralization in the camp and elsewhere on Vancouver Island. Because they are similar to and were probably intruded at the same time as the Coast Range batholiths on the mainland of British Columbia, the granitic rocks in the Zeballos belt and elsewhere on Vancouver Island have been referred to generally as "Coast Range Intrusives" (Gunning, 1932, p. 34), and for this particular belt as the Zeballos batholith.

The general form of this northwesterly trending belt of intrusives was probably determined by the regional, northwesterly trend of the volcanic and sedimentary formations. Except at the Central Zeballos mine, where easterly trending sediments influenced the emplacement of an easterly trending body of granodiorite, the emplacement of the individual intrusives has not been greatly influenced by local structures.

Within the area covered by this report, the writer has distinguished and outlined areas of four major types of intrusives, gabbro, hornblende diorite, granodiorite, and quartz diorite, and, in places, variations of these rock types. Quartz diorite, although the principal intrusive in the area and the most important economically because of its association with the rich gold veins of the camp, is the youngest of the major intrusive bodies and will, therefore, be described after the others.

GABBRO.

(1, Fig. 2.)

Gabbro, with unreplaced patches of volcanics, underlies a small part of the extreme southwest corner of the area mapped and continues for unknown distances to the northwest and southeast as a narrow belt at least 2,000 feet wide. The structure is generally massive and the texture is uniform, features that are well shown in the gabbro at the upper end of the Zeballos River canyon. Along the trail on the west side of the canyon of Zeballos River and along the hillside southwesterly from the canyon towards the Answer and Golden Portal properties, the gabbro contains volcanic inclusions up to 200 feet across, but even in such places gabbro is the principal rock type.

The gabbro is dark green, fine to medium grained, and in general appearance is similar to hornblende diorite found in the main belt of intrusives 2 to 3 miles farther upstream. However, the gabbro differs from hornblende diorite mineralogically in that it contains labradorite instead of andesine, and considerable augite with only a minor amount of primary hornblende.

This rock is not in contact with large bodies of granodiorite or quartz diorite, which makes its age relative to these rocks indeterminable. However, it is cut by granodiorite dykes and may possibly be older than the larger bodies of granodiorite and therefore older than the quartz diorite.

HORNBLENDE DIORITE.

(2, Fig. 2.)

Fine, even-grained hornblende diorite outcrops over a large area north of the Zeballos River. The rock is generally homogeneous but near its contacts with the older volcanic rocks holds angular inclusions of these rocks from a few inches to several feet in diameter, which in places are so numerous that the rock is a breccia. Within the area mapped as hornblende diorite, the largest area of uniformly homogeneous diorite is along the nose of the ridge extending southeasterly from the cabin on the F.L. property. This is towards the geographic centre of the general area of diorite and also towards the centre of the belt of intrusives and therefore probably represents the part of the diorite mass farthest in any direction from contact rocks.

The hornblende diorite contains inclusions of volcanic rocks in all stages of replacement but does not form clean-cut dykes in the surrounding volcanics. Its emplacement as an igneous rock does not appear to have been accompanied by pronounced fracturing and dyking of the older rocks, and in this feature it differs from the younger granodiorite and quartz diorite that have fragmented and dyked the border rocks to a marked degree.

On the mountain ridges in the northwest corner of the area the hornblende diorite and its inclusions of volcanics have been intensely fractured and dyked by granodiorite (Plate V). Although there is no sharp boundary between diorite not dyked and diorite dyked by granodiorite, their general distribution may be reasonably well determined (3, Fig. 2). The granodiorite dykes range in width from a few inches to 20 feet and in some places constitute nearly 50 per cent. of the outcrop area. They are particularly abundant on the ridge and high peak (elevation 4,041 feet) northwesterly from the Barnacle property. Granodiorite dykes cut the diorite at several places beyond the area outlined in Figure 2, but they are widely scattered and are never abundant in any one place.

GRANODIORITE.

(4, Fig. 2.)

Granodiorite underlies two areas, one southeasterly from the Cordova property and another on the Central Zeballos property.

The granodiorite near the Cordova is a massive, light-coloured granitic rock, generally recognizable by the almost white colour of the outcrops. Conspicuous white bluffs of this rock on the mountainside southeasterly from the Cordova cabin may be seen from a considerable distance. The contacts of the granodiorite with the surrounding diorite are irregular and gradational. No contact breccia has been formed, but the granodiorite near the contact is characterized by light-green mottling as though in such places considerable diorite had been absorbed by the granodiorite and had undergone recrystallization. As seen under the microscope, the granodiorite near the Cordova consists principally of oligoclase-andesine feldspar, quartz, and perthitic orthoclase.

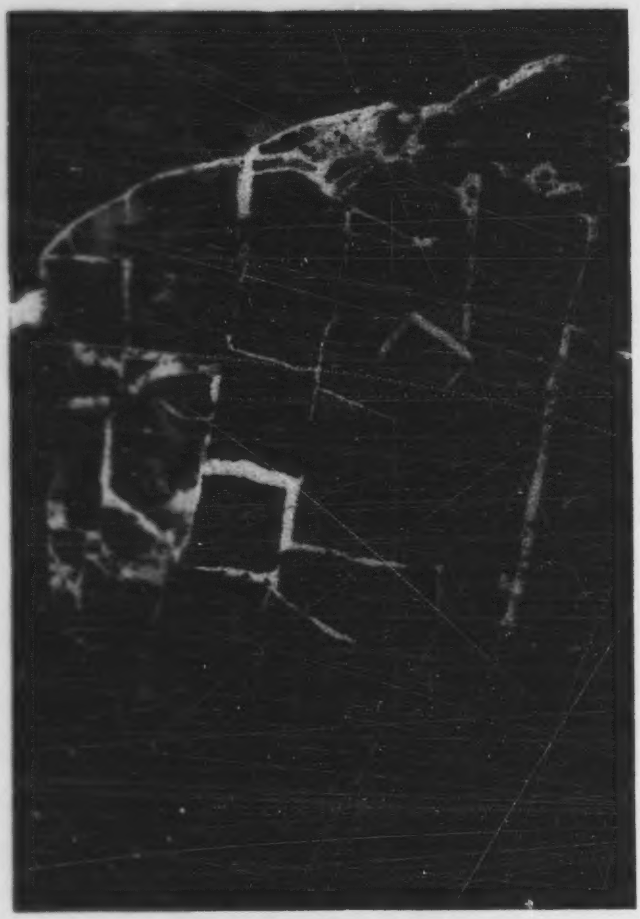

Plate V. Stringers of granodiorite cutting hornblende diorite, on ridge northwest of Barnacle property.

Two small circular areas 20 feet and 30 feet in diameter of whitish granodiorite that may be related to the Cordova granodiorite outcrop in the western branch of Lime Creek about 1,000 feet upstream from the Barnacle cabin.

The area of granodiorite on the Central Zeballos property extends about 1¼ miles from east to west and less than half a mile from north to south. The granodiorite is younger than the bordering limestone on the north and south but is older than the quartz diorite on the west. It has been traced easterly to bluffs on the west side of Nomash River and to an outcrop in the bed of the river. As Gunning (1932, Fig. 4) shows large areas of limestone and no intrusive rocks extending easterly from the river, the writer thinks that the outcrop in the river bed approximately marks the eastern boundary of this area of granodiorite. The granodiorite at Central Zeballos differs from that near the Cordova in being markedly porphyritic in appearance and in containing less orthoclase. The porphyritic appearance is produced by feldspar crystals one-sixteenth to one-eighth of an inch long in a fine-grained matrix. Under the microscope the large feldspar crystals are seen to be oligoclase in a crushed and recrystallized matrix of quartz, oligoclase, and orthoclase. The large feldspar crystals appear to have been corroded during the recrystallization of the matrix.

Most of the border zones of the Central Zeballos granodiorite are slightly schistose and contain numerous inclusions of volcanic rocks. The inclusions range from a few inches to several feet in diameter and vary in degree of recrystallization. Mineralogically, the inclusions that have undergone most intense recrystallization are almost identical in composition with the enclosing granodiorite. Scattered clusters of the calcium-magnesium amphibole actinolite are found towards the east end of the granodiorite area and suggest the recrystallization of calcareous material in some of the volcanics found as inclusions.

For about 300 feet from its contact with the underlying quartz diorite, the granodiorite is lighter in colour than average. This light-coloured granodiorite is porphyritic and usually schistose. Under the microscope it is seen to contain less biotite than the darker granodiorite but has the same large feldspar crystals and recrystallized groundmass.

The granodiorite appears to have formed largely by the metasomatic replacement of a volcanic rock. Light-green inclusions of volcanic rock, much of it completely recrystallized and possessing a mineralogical composition similar to that of the granodiorite, are seen in the granodiorite, not only close to the north and south borders of the area, but also towards either end. These recrystallized inclusions have a slight east-west schistosity parallel to the elongation of the granodiorite and to the strike of the sediments north and south of the granodiorite. The uniformity in mineralogy and in texture of the inclusions indicates an originally uniform rock, and the presence of some residual chlorite with the newly formed biotite suggests that the original rock was a greenstone, possibly a tuff or lava.

Although some of the granodiorite near the borders of the mass may have formed by assimilation or solution of wallrock fragments, probably most of the main mass originated by metasomatic replacement in the solid of the earlier rock. The marginal granodiorite possesses features characteristic of such metasomatic replacement and not the features such as would be expected were the marginal granodiorite formed by the assimilation or solution of wallrock fragments with subsequent crystallization from the resulting melt. Both the marginal and central granodiorite possess a "porphyritic" texture caused by clusters of large feldspar crystals in a medium-grained groundmass. The plagioclase crystals in these clusters possess a characteristic metasomatic sieve texture or structure caused by inclusions of small irregularly shaped grains of quartz and biotite. These irregularly shaped inclusions contrast with the well-shaped inclusions such as apatite found in phenocrysts that are formed by direct crystallization from a magma. The plagioclase crystals also have minutely crenulated borders, a feature characteristic of replacement crystals, as compared with the straight non-indented borders of magmatic phenocrysts. In general, where the porphyritic texture is not evident, the grain size is very uneven, a feature characteristic of replacement contrasted with the more even texture and grain of granitic rocks formed by crystallization from a melt and emplaced by forceful intrusion. As much of the granodiorite near the Cordova is similar in texture and in the form of plagioclase crystals, it may have an origin similar to that of the granodiorite on the Central Zeballos property.

The chemical analyses of relatively fresh granodiorite from the Central Zeballos mine given in the table on page 31 reveal features that suggest replacement. The content of silica and alumina is higher and the content of soda, lime, and potash is lower than in most granodiorites. If the granodiorite were formed by replacement of volcanic rocks with which sedimentary material was probably interbedded, the sedimentary material could account for the more than usual amount of silica and alumina.

Analyses of Fresh Granodiorite.

	1.	2.
	Per Cent.	Per Cent.
SiO_2	71.80	71.64
Al_2O_3	15.33	14.46
Fe_2O_3	0.61	0.84
FeO	2.84	2.30
MgO	1.06	0.22
CaO	1.44	2.04
Na_2O	3.25	2.97
K_2O	2.38	2.16
H_2O-	0.05	0.13
H_2O+	0.62	2.11
TiO_2	0.46	0.42
P_2O_5	0.13	0.14
MnO	0.06	0.06
FeS_2	......	......
BaO	0.10	0.10
Totals	100.13	99.59

Analyst: G. C. B. Cave, Chemical Laboratory, British Columbia Department of Mines.
1. From Central Zeballos mine, No. 2 adit, 50 feet from portal (*see* p. 30).
2. From Central Zeballos mine, No. 1 west adit (*see* p. 30).

QUARTZ DIORITE.
(6, Fig. 2.)

A large mass of quartz diorite forms the principal intrusive body in the area, and as most of the rich gold veins of the camp are within or close to it, it is the rock of principal economic interest.

The main mass of quartz diorite extends southeasterly from the Zeballos River, and although it can be seen on the ridges and mountain tops for at least 2 miles beyond the southeastern corner of the area mapped, prospectors report that granitic rocks do not extend much farther in a southeasterly direction. The length of the quartz diorite body, including contact breccia, within the area is 4 miles, and the total length, including that southeasterly from the map boundary, is probably between 6 and 8 miles; the width of the quartz diorite body at the northwestern end is about 6,000 feet, and the maximum width is about 11,000 feet.

The average quartz diorite is a speckled black and white massive rock with conspicuous jointing. Exfoliation tends to round the solid angles between the joint planes, which gives a bouldery or hummocky appearance characteristic of outcrops of this rock. This feature may be recognized from a distance. It has an even medium-grained texture (Plate VI) and consists mainly of quartz, oligoclase-andesine feldspar, and biotite. The texture is primary and does not show any sign of granulation or recrystallization that is so well shown by the granodiorite of probable replacement origin on the Central Zeballos property.

Chemical analyses of quartz diorite from the Central Zeballos and Prident mines, given in columns 1 and 2 of the table on page 32, indicate that it is a normal quartz diorite.

Analyses of Fresh and Altered Quartz Diorite.

	1.	2.	3.
	Per Cent.	Per Cent.	Per Cent.
SiO_2	65.10	67.56	65.12
Al_2O_3	14.91	15.51	16.18
Fe_2O_3	0.79	0.40	0.33
FeO	4.09	2.70	2.19
MgO	2.42	2.42	0.71
CaO	5.14	3.16	3.99
Na_2O	2.84	3.62	0.15
K_2O	1.8[illegible]	2.20	4.94
H_2O-	0.06	0.18	0.26
H_2O+	1.14	1.20	2.14
TiO_2	0.55	0.52	0.50
P_2O_5	0.19	0.11	0.14
MnO	0.09	0.05	0.07
FeS_2	0.49	....	....
BaO	0.07	....	....
CO_2	0.13	....	....
Totals	99.76	99.63	96.72

Analyst: G. C. B. Cave, Chemical Laboratory, British Columbia Department of Mines.
1. From Central Zeballos mine, No. 5 level, west face, relatively fresh.
2. From Privateer mine, 600 level, quartz diorite slightly altered, 1 foot from vein (see p. 43).
3. Same as 2, but rock from within vein shear and intensely sericitized (see p. 43).

The minerals of the quartz diorite lack any easily recognizable alignment, and the only obvious evidence of flow consists of widely separated, smooth, spindle-shaped inclusions that usually trend with the strike of the contact between the quartz diorite and the older rocks. These inclusions are more rounded and have been more intensely recrystallized than the wallrock inclusions found along the contacts and must have been incorporated at a considerable depth during the intrusion of the quartz diorite body.

Numerous quartz diorite dykes and, in places, contact breccia characterize the wallrocks of the quartz diorite. Several dykes and an isolated area of quartz diorite are found in the older rocks along the southwestern contact near the Privateer mine. Farther to the southeast, from the White Star to the Britannia M, the contact area is not exposed, and outcrops of the older rocks are separated from outcrops of the quartz diorite by unconsolidated material about 1,000 feet wide in the valley of Spud Creek. Many quartz diorite dykes are found along the northeastern contact, on the Central Zeballos property, and southeasterly along the contact to the edge of the map-area. The dykes were not found farther than 200 feet from this contact.

Zones of contact breccia less than 100 feet wide are found at several places along the northeastern contact of the quartz diorite. Much of the contact zone along the southwestern contact is drift covered, but in the few outcrops or workings near the contact with older rocks, such as underground in the Privateer mine, in No. 7 adit at the Spud Valley gold mine, in No. 4 adit on the Britannia M property, and along the bluffs to the southeast, contact breccia is not widespread.

At the northwestern end of the quartz diorite area, contact breccia is well developed, and since it is so conspicuously different from the homogeneous rock of the main area of quartz diorite, the contact breccia has been mapped separately (5, Fig. 2). The breccia consists of fragments of volcanic rocks (Plate VI) and, near the river, of fragments of hornblende diorite with quartz diorite filling the spaces between fragments. The fragments range in width from a fraction of an inch to large inclusions of green volcanic rock several feet across. The quartz diorite that seals the fragments together is usually not more than a few inches wide. In most of the inclusions the minerals have been recrystallized, resulting in a sugary texture.

The breadth of this zone of contact breccia, which is at least 2,000 and possibly 3,000 feet if outcrops of breccia on the northwest side of the river are included, sug-

Plate VI. Angular inclusion of volcanic rock in quartz diorite, 1100 level, Privateer mine. The inclusion is about 6 inches long, the white areas on the inclusion are patches of water. Note angularity of inclusion and the even-grained texture of the quartz diorite.

gests that the contact of the quartz diorite body along the northwest end dips much more gently than does the contact along the sides where the contact zones are much narrower. The lesser amount of contact breccia along the southwestern contact, as compared with the amount along the northeastern contact, suggests that the southwestern contact of the quartz diorite is steeper than the northeastern. These inferences are substantiated by the fact that the dip of the southwestern contact, as seen for several hundred feet vertically in the bluffs southeasterly from the Britannia M adits, is from 75 to 80 degrees southwestward, whereas the dip of the northeastern contact, as determined from contacts at several places in the Central Zeballos mine, is about 60 degrees northeastward.

The numerous quartz diorite dykes and the sharply fragmented contact breccias that characterize the contact zones of the quartz diorite intrusive, as compared with an almost total absence of these features associated with the hornblende diorite and granodiorite bodies, suggest that the quartz diorite intrusive was emplaced more forcibly and with less passive replacement of the wallrocks than the hornblende diorite and granodiorite. Quartz diorite forms the matrix for hornblende diorite fragments and, as dykes, cuts the granodiorite; therefore, it must have been emplaced after these rocks had formed and were solid enough to fracture. The productive gold-quartz veins occupy fractures that are within or not more than a mile from the quartz diorite. They are younger than the quartz diorite and have also a close spatial relationship to it, and it is probable that, though the vein matter need not have come from the quartz diorite, it may be genetically related in coming from the same deep source.

DYKE ROCKS.

The dyke rocks in the area include a wide variety of petrographic types, ranging from dark-green varieties rich in hornblende to light-grey varieties consisting mainly of feldspar, quartz, and very little hornblende. Some of these dykes appear to be older than the main intrusives of the area, but most of them are definitely younger. The older dykes include diabase and diorite, and the younger dykes include feldspar porphyry, dacite, granodiorite or quartz monzonite, aplite, and lamprophyre. In some places, as on the Central Zeballos, White Star, and Barnacle properties, dykes have been partly responsible for the localization of portions of the vein shears.

Numerous diabase dykes from 2 inches to 10 feet wide have been found in limestone, and although not seen in outcrops of the green volcanic rocks they have been seen in green volcanic rocks underground at the Mount Zeballos mine. A few diabase dykes are known to cut the larger intrusives, but it is uncertain whether they are of the same age as the diabase dykes that cut the limestone. Diabase dykes in the limestone near granodiorite have recrystallized, which suggests that at least some of the diabase dykes are older than the intrusives.

The diabase dykes are dark blackish-green. The narrow dykes are fine grained and porphyritic with visible feldspar phenocrysts one-eighth of an inch long and the wider dykes medium grained and non-porphyritic in texture. Under the microscope the dykes are seen to have a typical diabasic texture and to consist of laths of andesine intergrown with hornblende. The presence of films of fine-grained pyrite along joint planes is a conspicuous feature of many of the diabase dykes. Where the diabase dykes are in limestone near any of the larger areas of intrusives, they have been affected by the heat of the intrusion and possess a definite hornfels texture characteristic of recrystallization, and they contain sufficient biotite to give the rock a definite brownish cast.

Diorite dykes have been seen at several places in the volcanics, seldom less than half a mile from the major intrusives; they have also been seen in gabbro on the Tagore property. The dykes range in width from 4 to 12 feet and extend for several hundreds of feet along the strike, as is shown by a dyke that outcrops in the Zeballos River beneath the Ford bridge. They may be traced by scattered outcrops southerly up the mountainside for nearly 1,000 feet. The diorite in these dykes is a green, medium-grained, massive rock that consists of an intergrowth of andesine and hornblende. The diorite dykes differ from the diabase dykes in having more hornblende and a less calcic feldspar, and although they are mineralogically similar to the large areas of fine hornblende diorite found north of the river, they do not cut this diorite. Although they cut the gabbro at the Tagore, they have not been seen in the other intrusives. It is possible, therefore, that both the gabbro and the diorite dykes are older than the hornblende diorite, granodiorite, and quartz diorite. The relative ages of the diorite dykes and diabase dykes could not be determined.

Feldspar porphyry dykes from 3 to 50 feet wide cut the limestone and volcanics in the area. They cut diabase dykes in the bed of the north fork of the Zeballos River and in the bed of the Nomash River and cut the rocks of the larger intrusive bodies at many places; they are, therefore, younger than any of these rocks.

The feldspar porphyry dykes are light grey and massive, and consist of conspicuous phenocrysts of andesine, one-eighth to one-quarter of an inch long, set in a medium-grained groundmass of feldspar of similar composition. Most of them contain a moderate amount of brown hornblende, and some a little biotite and quartz.

A chemical analysis of a typical feldspar porphyry is given in column 1 of the table on page 35.

An elliptical-shaped area of feldspar porphyry is found in green volcanic tuff about 1,000 feet southwesterly from the uppermost level of the Mount Zeballos mine. The rock is dark grey, massive in structure, and consists of closely packed andesine phenocrysts one-eighth to one-half an inch in size. This rock, of doubtful origin, resembles the feldspar crystal tuff found in the Mount Zeballos vein but does not possess the fragmental texture of a tuff. It does not appear to extend far along its general trend as would be expected of a flow, and it is probably a small stock-like intrusive body.

Dacite dykes a few inches to 25 feet wide cut the granodiorite at the Central Zeballos mine where they appear to have had some structural control on the localization of the vein shear. Dacite dykes also cut quartz diorite on Monckton Creek, granodiorite on the Cordova property, and both lime-silicate rocks and quartz diorite in the Privateer mine.

The dacite dykes are light greyish-green, usually massive in structure, and some of the smaller dykes show flowage. They are generally porphyritic in texture with conspicuous crystals of feldspar one-sixteenth to one-eighth of an inch in size in a fine-grained groundmass. Under the microscope the phenocrysts are seen to be andesine set in a groundmass of andesine, quartz, and a little hornblende. The texture of the groundmass is entirely primary, and the minerals have been neither brecciated nor have they recrystallized as has the surrounding granodiorite.

A chemical analysis of a porphyritic dacite dyke from the Central Zeballos mine is given in column 2 of the table below. The composition is that of a dacite or quartz andesite, but one with a more than average amount of soda.

Analyses of Feldspar Porphyry and Dacite Dykes.

	1.	2.
	Per Cent.	Per Cent.
SiO_2	69.98	73.74
Al_2O_3	13.33	15.20
Fe_2O_3	0.58	0.37
FeO	3.11	1.84
MgO	2.40	0.18
CaO	3.92	1.16
Na_2O	3.87	4.98
K_2O	1.14	1.66
H_2O-	0.17	0.06
H_2O+	1.22	0.62
TiO_2	0.52	0.07
P_2O_5	0.11	0.05
MnO	0.04	0.02
BaO	0.06	0.09
Totals	100.45	99.94

Analyst: G. C. B. Cave, Chemical Laboratory, British Columbia Department of Mines.
1. From an 8-foot feldspar porphyry dyke in limestone in bed of Nomash River (see p. 34).
2. Dacite dyke from Central Zeballos mine, No. 2 crosscut, 190 feet south of the vein (see above).

Light-coloured granodiorite dykes, from one-eighth of an inch to 4 inches thick, have been seen in quartz diorite in the Central Zeballos mine and in places are so numerous that the rock is a breccia. In colour and grain size, the dykes are similar to aplites, but they do not possess the sugary texture nor the mineral composition of aplites. They contain about equal amounts of orthoclase and andesine with moderate amounts of quartz. Rocks of the composition of these dykes have been occasionally referred to as quartz monzonite but will be referred to here as orthoclase-rich granodiorite. These dykes possess much more orthoclase and do not have the same texture as the larger granodiorite intrusive bodies at the Central Zeballos mine and near the Cordova property. Light-coloured orthoclase-rich granodiorite dykes cut the quartz diorite at the Privateer mine.

Small dykes or stringers of aplite, half an inch to 3 inches wide, cut the granodiorite at the Central Zeballos mine near the quartz diorite and, in general, are common along the northeastern contact of quartz diorite intrusive. They have also been found at several places within the quartz diorite (Plate VII) but are usually near the borders

Plate VII. Aplite stringers cutting quartz diorite, 1100 level, Privateer mine. The widest stringer is 2 inches wide.

of the mass. The aplites possess the sugary-trained texture typical of all aplites and consist of the usual minerals, quartz and orthoclase.

Only one lamprophyre dyke was seen in the area. In the No. 1 adit west, of the Central Zeballos mine, a dark-coloured dyke 6 feet wide cuts the granodiorite wallrock of the vein. This dyke consists of a fine, even-grained aggregate of andesine, green hornblende, brown biotite, and a little quartz. All the minerals appear fresh and most show well-developed crystal boundaries producing the texture characteristic of lamprophyres.

CHAPTER III.—STRUCTURAL GEOLOGY.

FOLDS.

The major structure in the area is a monoclinal fold that strikes northwesterly and dips 40 to 60 degrees southwestward. This fold is modified by a major dragfold between Lime and Contact Creeks and by minor dragfolds near the quartz diorite.

The major dragfold trends northwesterly with the crest of the fold following Lime Creek and with the trough following the ridge about 2,000 feet to the east. The limestone on the eastern limb of the dragfold dips 50 degrees southwestward and is in conformable contact with the underlying volcanics along Contact Creek, and on the western limb of the dragfold it dips steeply 65 to 70 degrees southwestward under magnetite and overlying volcanics on the F.L. property (Fig. 37). The western limb of the dragfold at the F.L. property has been modified by a cross-flexure that trends southwesterly down the limb of the fold, so that on the northwest the rocks dip steeply northwestward and on the southeast they dip steeply southeastward.

The limestone and sedimentary rocks on the Central Zeballos property and southwesterly from the mine trend easterly; all have steep to vertical dips. The north band of limestone at the Central Zeballos mine appears to dip about 70 degrees southward, and the south band dips about vertical. These dips suggest a syncline, but no outcrops of lime and silicate rocks are found north of the north band of limestone similar to those found south of the south band of limestone. The north band of limestone differs from the south band in being rather pure limestone, and at only a few places along the contact with the granodiorite does it have any lime-silicate minerals, whereas the south band contains a large amount of lime silicate, not only close to contacts, but also within the band itself. The lack of repetition of beds and dissimilarity between the two bands of limestone militate against the concept of a syncline, and it is most probable that the north and south outcrop areas of limestone are two separate bands of sediment rather than the two limbs of a fold. In support of this, it may be noted that the intervening granodiorite appears to have replaced volcanic rocks, not only at the surface, but also to a depth of 1,000 feet.

Cross-flexures occur in the band of light-coloured rocks at the Privateer (Fig. 8*) and Mount Zeballos mines (Fig. 19). A trough at the Privateer mine and a ridge at the Mount Zeballos mine trend westerly down the regional dip. Some minor dragfolds (Plate VIII and Fig. 10*) occur on the Privateer flexure, and, though not proven, a moderately large dragfold probably occurs on the Mount Zeballos flexure (Fig. 20).

Vertical to northeastward dips in the tuffs up Van Isle Creek indicate a local dragfold, with the crest lying a short distance to the west and the trough a short distance to the east of the creek. Farther to the southwest, in the limestone and associated tuffs at the Prosperity and the Beano mines, which are close to the belt of augite diorite, steep and vertical dips indicate an oversteepening of the regional dip that is probably related to the intrusion of the diorite.

FAULTS.

Although no widespread shearing of the rocks or development of schistose areas were seen within the map-area, several faults were noted. On only one has the displacement been more than a few feet. This is a major fault that follows the north fork of the Zeballos River and has a displacement which, though unknown, must have been considerable.

This fault, strike north, cuts northwesterly trending formations and has brought limestone on the east side of the river against volcanics on the west side of the river. The writer did not extend his mapping far enough to determine direction and amount

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* *See* Figures 8 and 10 in pocket.

Plate VIII. Small anticlinal portion of a dragfold in lime-silicate rocks and tuffs, Privateer mine, 1100 level; axial plane of fold vertical. Maximum width of fold within the plate is 3 feet.

of displacement along this fault, but Gunning (1932, p. 36) says of the fault: "It forms the western boundary of the infolded masses of limestone and the east side of the fault has moved down, and possibly northward, relative to the west side."

Limestone outcropping in the river bed was sheared over a width of 10 feet by movement along the fault. The shear planes are spaced 2 inches to 2 feet apart and dip 60 degrees eastward. At other places where the actual fault is not evident, its existence in the stream bed may be inferred from the non-continuance of westerly striking feldspar porphyry dykes from the limestone outcrops on the east bank into outcrops of volcanic rocks on the west bank of the river. As the most southerly outcrop in the river is at a point about 1,000 feet north of the junction with the Nomash River, the fault cannot be traced southerly from this point. The writer feels that the fault does not extend as far south as the Central Zeballos property, as no suggestion of the fault, either from evidence of intense shearing, a prominent feature along its trace in the Zeballos River, or from evidence afforded by offsetting of rock formations, can be seen in the rock formations on this property. Although a lobe of granodiorite extends northerly from the side of Lot 1046, which suggests that it might follow the fault, the rocks are well exposed here, and no evidence of a major fault zone was seen. The 900 crosscut on the Central Zeballos property (Fig. 29) crosses the projected position of the fault, but no sign of it was seen in this crosscut. Although the contact of the quartz diorite where it crosses the Central Zeballos property is sufficiently well exposed to indicate offsetting along a fault, no offset of the amount required by the Zeballos River fault is evident.

As the fault does not appear to cut the limestone or the granitic rocks on the Central Zeballos, its age relative to these rocks cannot be determined. However, in the bed of the Zeballos River it cuts feldspar porphyry dykes, which are younger than the granitic rocks, and therefore it is inferred that the fault is younger than the youngest igneous rocks. The age of the fault and the absence of dykes or veins following its trend militate against the thought that the fault was an influencing factor in localizing either intrusive rocks or veins.

In addition to the principal fault just described, several smaller faults or shear zones have been seen.

At the point where Fault Creek joins the north fork of the Zeballos River, a shear zone 2 to 4 feet wide, strike easterly and dip vertical, offsets the northerly continuation of a feldspar porphyry dyke for 5 feet eastward. Farther up Fault Creek at the Goldspring camp a shear zone 15 feet wide was seen in the bed of the creek. The shearing strikes easterly and dips 55 degrees northward and may or may not be continuous with that seen at the mouth of the creek. The offset could not be determined at the Goldspring camp.

A well-defined fault follows the bed of West Maquinna Creek for a considerable distance. The fault, strike north 40 degrees west, dip 60 degrees northeastward, consists of 10 inches of intensely crushed rock and a little calcite, but no other mineralization. The offset along this fault could not be determined.

Apart from the many vein shears and small cross-faults, all of which will be described in the chapter on property descriptions, no other faults of importance were noted in the map-area.

CHAPTER IV.—ECONOMIC GEOLOGY.

The mineral deposits of the area include gold-bearing quartz veins and high-temperature replacement deposits, which contain copper and iron, and one gold-bearing replacement deposit. Magnesian limestone in the area is potentially of economic importance. The gold-quartz veins are economically the most important.

REPLACEMENT DEPOSITS.

Deposits of high-temperature minerals replacing limestone or limy sediments are found along contacts with diorite or granodiorite but not along contacts with quartz diorite. The iron showings on the F.L. and Ridge (pp. 125–128) consist principally of magnetite, on the Churchill (pp. 131–134) of magnetite and pyrrhotite, and the copper showings on the Maquinna (p. 121) and Central Zeballos (p. 112) properties consist principally of chalcopyrite with only minor amounts of magnetite or pyrrhotite, and the gold showings on the Beano (pp. 135–138) consist of pyrrhotite carrying appreciable amounts of gold. A small amount of molybdenite was found with replacement chalcopyrite on the Scorpio claim in a road-cut between Privateer and Central Zeballos. The copper deposits are small and are unimportant economically, but the large magnetite deposit and perhaps some of the smaller magnetite deposits may prove to be valuable. The one replacement deposit with gold, the Beano, is still a prospect.

The copper-iron-gold replacement deposits appear to represent a period of mineralization earlier than that of the gold-quartz veins.

GOLD-QUARTZ VEINS.

The camp became famous in 1935 for its rich gold-bearing quartz veins that have yielded the entire production of gold and silver. The history and production of the camp to 1948 are outlined on pages 12 to 15.

Vein Structure.—Most of the gold-bearing veins consist of quartz-sulphide filling in well-defined fault fissures, rarely more than a foot wide, that maintain a fairly uniform strike and dip for considerable distances (Plate IX). In places the quartz-sulphide vein matter may be lacking and only sheared rock present. The walls of most of the quartz-sulphide veins are marked by films of gouge; frozen walls are uncommon.

Some of the gold-quartz veins occur in sheeted zones up to 4 feet wide. These zones consist of joints spaced 2 to 8 inches apart and contain either gouge films or quartz-sulphide stringers an eighth of an inch to an inch wide. Along the strike a sheeted zone may change into a narrow shear containing a lenticular quartz-sulphide vein, a tendency well exemplified by the Goldfield vein.

Although wide shear zones containing mineralized veinlets of quartz are uncommon, a shear zone about 50 feet wide has been found on the Big Star property of the Spud Valley Gold Mines, Limited, and may prove important.

Vein Matter.—This consists of sulphides and gold in a gangue of quartz and some carbonate. Most of the vein matter is banded either by an alternation of quartz and sulphides or by an alternation of the different sulphides themselves. Comb texture, so-called because of the comb-like appearance of pyramid-shaped quartz crystals that project inward from either wall of the vein, is common (Plate X). The spaces between the crystals are commonly filled with sulphides.

Sulphides are abundant in most of the Zeballos veins. They comprise about one-tenth to one-half of the vein matter and probably average about one-quarter of it. They include, in order of abundance, pyrite, sphalerite, arsenopyrite, chalcopyrite, galena, pyrrhotite, and a little marcasite.

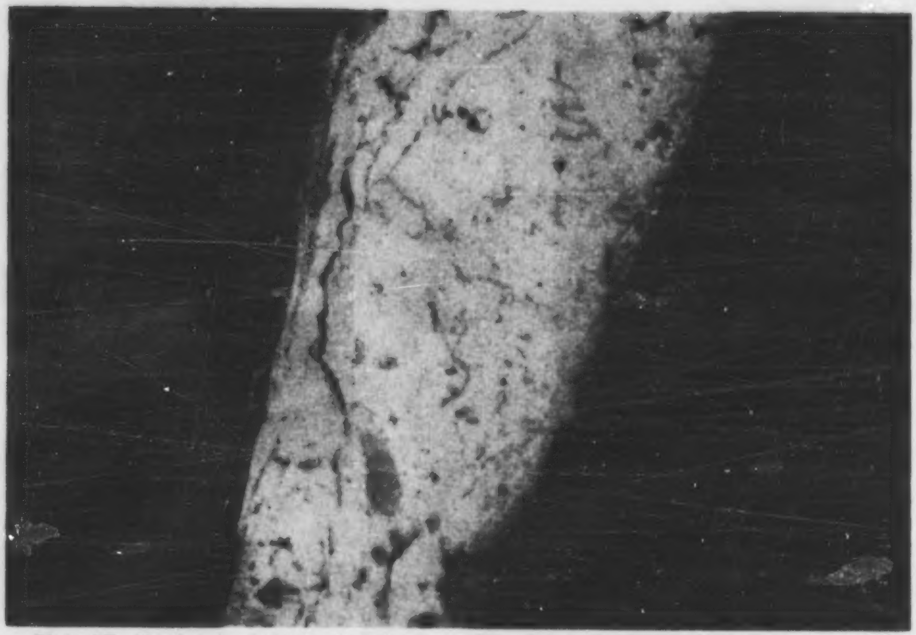
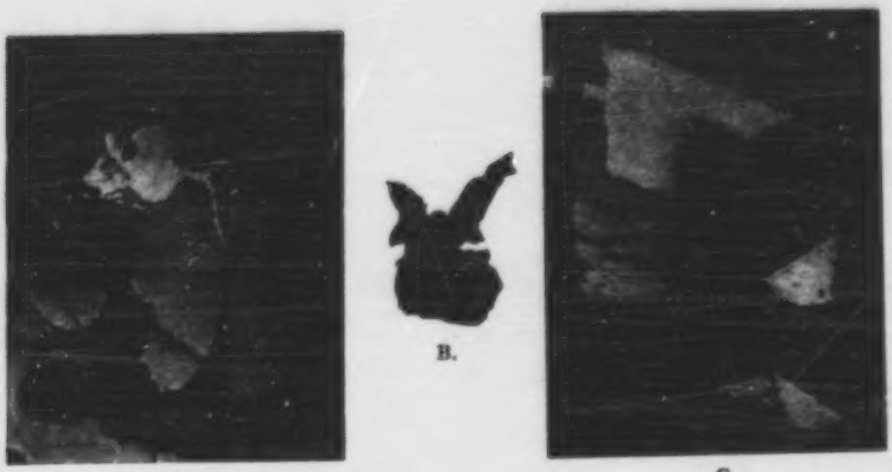


Plate IX. No. 1 vein, 1100 level, Privateer mine, showing vein in back, cutting banded lime-silicate rocks. The vein is 1 to 1½ feet wide.

Plate X. Comb texture, in quartz vein, about 6 inches wide, 900 level, Central Zeballos mine.



A. B. C.

Plate XI. A—Gold (white) pseudomorphic after arsenopyrite (grey) in a gangue of quartz (black). B—Crystalline gold (natural size) from Zeballos, presented to the Department of Mines by the late Albert Bloom. C—Gold (white) replacing fractured pyrite (grey) in a gangue of quartz (black).

(Cuts for A and C by courtesy of Western Miner.)

Gold is visible in much of the vein matter, but commercial ore may contain no gold recognizable by the unaided eye. Pyramidal crystals of gold up to three-quarters of an inch long were found in the Goldfield vein; large masses of hackly gold have been found in the Privateer veins; and gold in crystals up to one-eighth of an inch on the cube-edge have been found in several veins in the camp.

The mineral associations of the gold are varied. As may be seen in polished sections it replaces arsenopyrite, pyrite, and galena, and is found along the contact of quartz and any one of the sulphides, galena, sphalerite, or pyrite. It has also been seen occasionally as wisp-shaped areas entirely in quartz where it is usually seen to be moulded around the ends of pyramid-shaped crystals of quartz.

The distribution of the gold is fairly constant. In the quartz-sulphide ore the amount of gold is not only proportional to the sulphide content, but is also dependent on the presence of sphalerite and galena. The reason is not obvious. It is most likely that the gold, though slightly later in time of deposition, came in with the surge of mineralization that brought in the galena and sphalerite. The galena and sphalerite, though not necessarily abundant, usually indicate gold. Quartz veins that contain either pyrite or arsenopyrite only do not as a rule contain much gold.

Crushed rock in vein shears containing gold-bearing stringers, even though mineralized with disseminated crystals of pyrite, is usually low in gold. Despite the high gold content of much of the vein matter, assays of wallrock along rich veins show that no gold of economic importance seeped into the wallrock of the veins.

Quartz is the principal gangue mineral in the veins, but calcite occurs sparingly.

Brecciated vein matter characterizes the filling in parts of many of the veins. It consists of fragments of wallrock from a quarter of an inch to 10 inches across in varying stages of alteration, the less altered fragments being quite angular, whereas the more altered fragments have had their sharp corners rounded and are now elliptical. In some places the quartz that forms the matrix of the vein breccia has completely replaced a rock fragment and left only an angular patch of quartz slightly darker than the rest of the vein quartz.

The banding and crustification characteristic of much of the vein matter indicate that the vein minerals were deposited in a moderately orderly sequence. As inferred from a study of the banding and from a microscopic study of mineral relationships in polished sections of the ores, the sequence, from oldest to youngest, is as follows: Pyrrhotite and some sphalerite, arsenopyrite, pyrite, sphalerite, chalcopyrite, galena, and gold. The deposition of quartz appears to have started shortly after the deposition of pyrrhotite and to have been repeated several times before the final stages of mineralization. Carbonate and a little marcasite appear to have been the last vein minerals formed.

The earliest quartz is a fine-grained dark-grey variety containing very fine-grained or dusty arsenopyrite and pyrite; such quartz is common on the walls of many of the veins, and in most veins less than one inch in width comprises the full width of the vein matter. The later quartz is usually white and markedly crystalline, and where open spaces in the veins exist, well-formed quartz crystals extend toward the central part of the vein. The latest quartz is white, carries neither sulphides nor gold, and occurs as irregular veinlets or stringers that cut all the earlier vein matter.

Wallrock Alteration.—Alteration has occurred along the veins in all rock types cut by the veins, but it has been most intense where the wallrock is granodiorite or quartz diorite.

Granodiorite and quartz diorite, either adjacent to the veins or as the crushed material in the vein shears, have been altered to a silvery white rock. The plagioclase of these rocks has been completely sericitized and the biotite and hornblende have been completely destroyed; their former presence is indicated only by chlorite patches.

Chemical analyses of relatively unaltered quartz diorite, in which the feldspar contains only a few shreds of sericite and of intensely altered, silvery-white quartz diorite, in which the ferromagnesian minerals have been destroyed and the feldspar replaced by sericite, are given in columns 2 and 3 of table on page 32. Noticeable chemical features of this alteration are the decrease in the altered rock of FeO and MgO resulting from the destruction of biotite, hornblende, and chlorite, and the decrease in Na_2O and increase in K_2O resulting from the destruction of plagioclase and the development of sericite, a hydrous, potash mineral. The analyses also indicate that as there was very little orthoclase in the original rock, the plagioclase must have contained some potash, and that the sericite is not the soda-bearing variety paragonite, indistinguishable from the potash variety. The increase in H_2O—, combined water, is compatible with the development of sericite in the altered rock.

The lime-silicate rocks have been only slightly altered along the vein walls. The feldspar crystal tuff, green volcanic tuff, and lava have been altered for distances up to 6 inches from the vein shear to a light-buff, dense rock that contains small pyrite cubes. Under the microscope this altered rock is seen to consist of, in addition to pyrite, a felted mass of sericite and carbonate.

Structural Control of Vein Formation.—The producing mines of the camp are in and around the northwestern end or nose of the quartz diorite intrusive body (Fig. 2).

Although promising veins have been found, no producing mines have as yet been developed in the quartz diorite southeasterly from this nose, nor in the other intrusive rocks northwesterly from it. This distribution of producing properties suggests that the nose of the quartz diorite was the locus of structural deformation and gold mineralization within the camp.

A study of the fracture patterns into which the veins of the producing area fit (*Fig. 3*) and of the features of the veins suggests reasons for the localization of the ore.

It has been found that those veins or parts of veins that follow or approximately follow the direction of tension in any fracture pattern, and therefore occupy breaks formed by tension, are the most favourable for the localization of ore. For this reason it is important to determine which veins have been formed by tension and which by shearing stress.

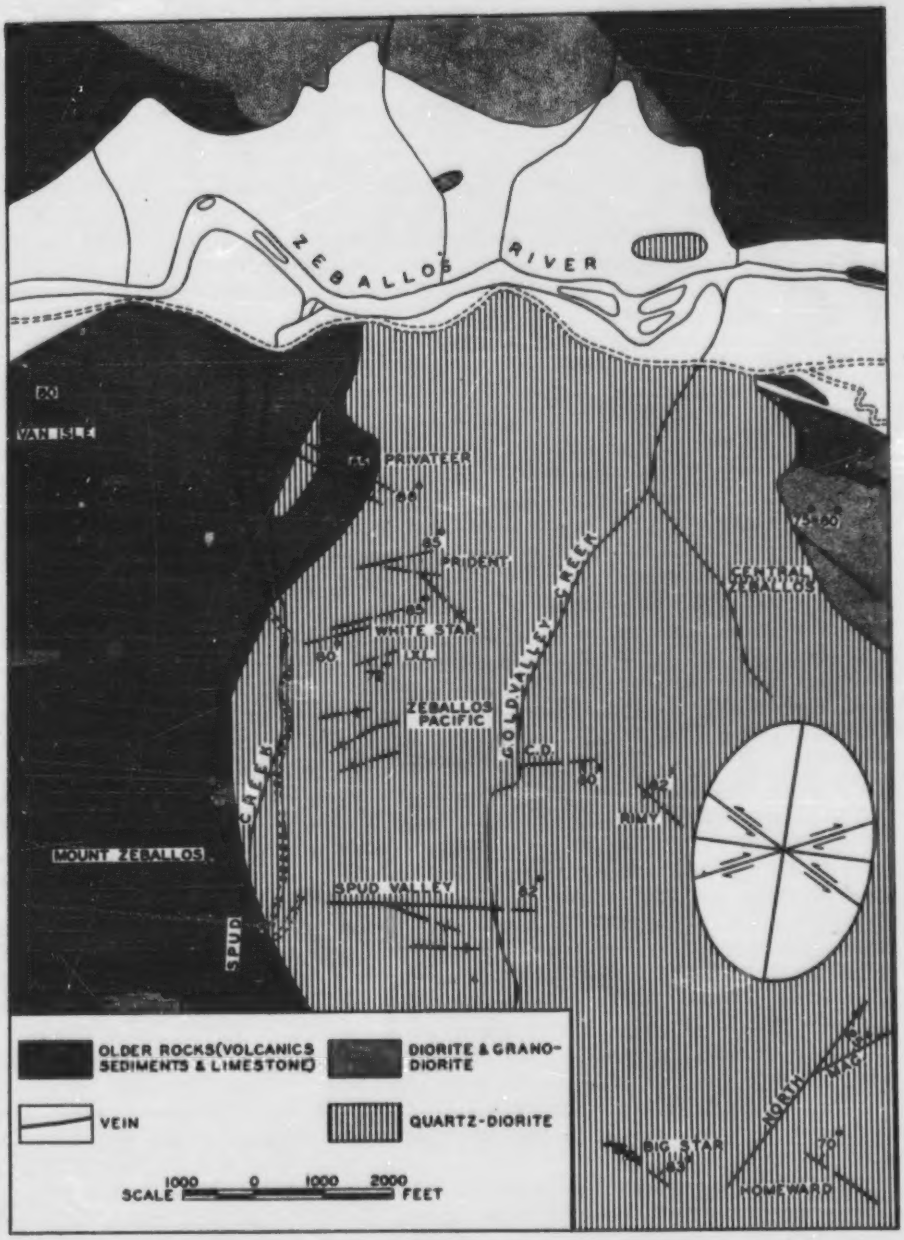

ZEBALLOS RIVER
80
VAN ISLE
PRIVATEER
60
65
PRIDENT
65
WHITE STAR
60
I.X.L.
ZEBALLOS PACIFIC
GOLDVALLEY CREEK
C.O.
80
62
RIMY
CENTRAL ZEBALLOS
75-80
MOUNT ZEBALLOS
SPUD VALLEY
62
SPUD CREEK
BIG STAR
63
NORTH MAC
70
HOMEWARD
OLDER ROCKS(VOLCANICS SEDIMENTS & LIMESTONE)
DIORITE & GRANO-DIORITE
VEIN
QUARTZ-DIORITE
SCALE 1000 0 1000 2000 FEET

Fig. 3. Fracture pattern of the veins within the producing area of the Zeballos mining camp.

The formation of the fractures was a consequence of the deformation of the quartz diorite and may be studied with the help of the conventional strain ellipsoid set up corresponding to the conditions of deformation or strain of the quartz diorite but without indicating the character and direction of the actual stresses that produced the deformation.

As the Zeballos Pacific (formerly Zeballos Gold Peak) vein shears, strike north 35 degrees east and dip vertical, and the Big Star vein shear, strike east-west and dip vertical, are accompanied by more crushed rock and gouge than the shears of a different strike, they appear to be along the directions of maximum shearing stress. Several other veins that are also accompanied by abundant gouge and sheared rock strike approximately north-northeasterly and easterly and have nearly vertical dips. These two directions followed by the Zeballos Pacific and the Big Star vein shears are considered to be the directions of maximum shearing stress, not only because of the abundance of crushed rock and gouge, but also because the relative directions of movement along these shears—namely, the westerly wall of north-northeasterly striking veins to the north and the north wall of easterly striking veins to the west—are in accordance with those required by two intersecting shear directions belonging to the same fracture pattern.

The directions of maximum shearing stress having been determined, it is necessary, before the ellipsoid may be oriented, to decide whether the axis of least strain of the strain ellipsoid bisects the obtuse or acute angle between these directions. As the absence of schistosity and cleavage in the older rocks and the absence of gneissosity in the quartz diorite suggest that the rocks were deformed under light load and consequently would fracture as brittle material, it follows[*] that the axis of least strain bisects the acute angle between the planes of maximum shearing stress in the strain ellipsoid. When the ellipsoid is thus oriented, the axis of least strain that bisects the acute angle between these directions of maximum shearing stress is horizontal and trends north 62 degrees east, the axis of greatest strain is horizontal and trends north 28 degrees west, and the axis of intermediate strain is vertical. This orientation of the strain ellipsoid is shown by the ellipse in Figure 3, the intermediate axis of the ellipsoid being perpendicular to the plane of the paper.

A study of the ellipsoid oriented as in Figure 3 will show that the planes of tension normal to the direction of greatest strain are vertical and strike north 62 degrees east. As a consequence, veins within the area to which the fracture pattern applies (Fig. 3) and which follow or closely follow this direction are presumed to have formed under conditions of tension. Several examples of such veins may be found. They include the No. 3 vein and the southwestern part of No. 1 vein on Privateer, parts of the Goldfield vein on Spud Valley, diagonals from the Big Star shear, and the gash veins that branch from many of the main veins.

The physical nature of the veins and vein shears that strike close to north 62 degrees east support the above deduction, that they were formed under conditions of tension. They are accompanied by only small amounts of crushed rock and gouge and are relatively short in length, particularly the gash veins. These features contrast with those possessed by the vein shears along the direction of maximum shearing stress and are normally considered to be features possessed by veins formed by tension.

As it has been found that fractures and consequently veins formed under tension are the most favourable for ore, those veins or parts of veins that strike close to north 62 degrees east and are vertical are the most likely to contain the best oreshoots. This appears to be true of several of the veins in the camp, details of which will be described in the individual property descriptions of Chapter V.

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[*] Nevin, C. M.: Principles of structural geology, John Wiley & Sons, New York, 2nd edition, 1936, p. 26.

MAGNESIAN LIMESTONE.

A large body of limestone that contains sizeable masses of magnesian to dolomitic limestone* is on the property of the Central Zeballos Gold Mines, Limited, where it is cut by the 900 crosscut adit (Figs. 29 and 30†). With the exception of a small deposit on West Redonda Island,‡ little has been recorded of other limestone high in magnesia in the coastal area of British Columbia. It is possible that the other known bodies of limestone in the Zeballos area contain sizeable masses high in magnesia, but their inaccessibility makes any magnesian or dolomitic limestone that may be found in them of questionable economic significance. The deposit on the Central Zeballos property therefore appears to be the only known one of considerable size reasonably close to transportation in the coastal area.

In the examination of the limestone in the 900 crosscut in the Central Zeballos mine, it was observed that two distinct but intermingled colour types were present, one dark grey and the other strikingly white. An analysis of a specimen of the grey limestone showed that it was a normal calcium limestone containing 53.7 per cent. CaO and 1.65 per cent. MgO, and a specimen of the pure white limestone was found to be dolomitic limestone containing 19.6 per cent. MgO and 32.7 per cent. CaO. In June, 1949, the limestone in this crosscut was sampled thoroughly because of its high content of magnesia and because it was only 6 miles by road from tidewater at Zeballos.

As the two types of limestone were intimately intermingled, the grey occurring in streaks or patches in the white and vice versa, the white occurring similarly in the grey, it was necessary to take a large number of samples at close intervals to determine, with a reasonable degree of accuracy, the distribution of the limestone high in magnesia. Accordingly, the writer took rock chips, each measuring approximately 3 by 3 by 2 inches, every 6 inches to a foot apart for a horizontal distance of 10 feet for each sample at waist-height along the northeastern wall of the crosscut. Analyses of the 103 samples taken in the crosscut and the six samples taken along the base of the bluff outside the portal are given in the table on pages 47 and 48. In this table the locations of the samples taken in the crosscut are given as measured from the portal of the crosscut, and the location of the samples taken outside the portal of the crosscut are given as measured along the base of the bluff northeasterly and southwesterly from the portal.

As may be seen in the first and third columns in the table on pages 47 and 48, the material highest in magnesia in the 900 crosscut is a 70-foot section that extends from 210 to 280 feet from the portal and averages 17.9 per cent. MgO. A 20-foot section adjoining the 70-foot section on the northern side 190 to 210 feet from the portal averages 13.8 per cent. MgO, and a 50-foot section adjoining the southern side of the 70-foot section 280 feet to 330 feet from the portal averages 13.5 per cent. MgO. The remaining limestone in the crosscut, with the exception of a few isolated 10-foot sections, averages considerably less in MgO, most of it less than 10 per cent. MgO. It is worthy of note that the predominantly white sections are highest in magnesia, and that the grey sections or the predominantly grey sections streaked with white have the composition of calcium limestone. Samples of the white material contain the most magnesia and consist almost entirely of the mineral dolomite.§ Samples that contain less than 19 per cent. magnesia do so because of a content of residual grey or calcium limestone that is composed principally of calcite.

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* *See* footnote p. 17.

† *See* Figure 30 in pocket.

‡ Goudge, M. F.: Limestones of Canada, Part IV, Western Canada; Mines Branch, Dept. of Mines, Ottawa, pp. 161–163, 1944.

§ *See* discussion, pp. 17 and 18.

Analyses of Limestone, 900 Crosscut, Central Zeballos Mine.

Distance from Portal.	Colour of Limestone.	MgO.*	CaO.	R_2O_3.†	Insol.‡
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
0–10 feet	Grey	§	......	......	......
10–20 feet	Grey and white	§	......	......	......
20–30 feet	Grey and white	§	......	......	......
30–40 feet	Grey and white	§	......	......	......
40–50 feet	Grey and white	§	......	......	......
50–60 feet	Grey and white	§	......	......	......
60–70 feet	Grey and white	§	......	......	......
70–80 feet	Grey and white	§	......	......	......
80–90 feet	Grey and white	§	......	......	......
90–100 feet	Grey and white	§	......	......	......
100–110 feet	Grey and white	§	......	......	......
110–120 feet	Grey and white	§	......	......	......
120–130 feet	Grey and white	§	......	......	......
130–140 feet	Grey and white	§	......	......	......
140–150 feet	Grey and white	§	......	......	......
150–160 feet	White	§	......	......	......
160–170 feet	White	9.6	44.4	0.3	1.0
170–180 feet	White	10.7	......	......	......
180–190 feet	White	10.1	......	......	......
190–200 feet	White	15.2	38.2	0.4	1.1
200–210 feet	White	12.4	41.4	0.2	0.9
210–220 feet	White	19.0	33.9	0.3	2.2
220–230 feet	White	17.5	35.5	0.2	1.0
230–240 feet	White	18.5	34.5	0.3	0.6
240–250 feet	White	18.0	35.0	0.2	0.5
250–260 feet	White	17.5	35.5	0.3	0.9
260–270 feet	White	18.3	34.8	0.2	0.6
270–280 feet	White	16.4	36.9	0.2	0.6
280–290 feet	White	12.3	41.2	0.3	1.7
290–300 feet	White	12.0	40.2	0.3	3.9
300–310 feet	White	16.6	36.3	0.3	0.5
310–320 feet	White, a little grey	11.9	38.6	0.4	6.6
320–330 feet	White	14.7	38.3	0.5	2.2
330–340 feet	White with tiny grey streaks	10.1	43.7	0.4	1.7
340–350 feet	White, a little grey	§	......	......	......
350–360 feet	White	13.3	39.5	0.3	2.0
360–370 feet	White with streaks of grey	13.9	39.0	0.7	3.9
370–380 feet	White with a little grey	9.8	42.8	0.4	4.5
380–390 feet	White and grey	9.5	42.6	0.4	6.2
390–400 feet	White and grey	17.1	35.8	0.3	2.8
400–410 feet	Grey	10.9	41.5	1.0	5.1
410–420 feet	Grey	10.2	40.0	2.0	7.4
420–430 feet	Grey and white	§	......	......	......
430–440 feet	White and grey	§	......	......	......
440–450 feet	White	§	......	......	......
450–460 feet	Grey	§	......	......	......
460–470 feet	Massive grey	§	......	......	......
470–480 feet	Grey and white	§	......	......	......
480–490 feet	Grey	§	......	......	......
490–500 feet	White	11.5	42.5	0.3	1.9
500–510 feet	Grey and white	7.5	47.2	0.1	0.9
510–520 feet	Grey and white	6.1	48.6	0.3	0.9
520–530 feet	Grey	§	......	......	......
530–540 feet	Grey	6.4	48.3	0.2	0.9
540–550 feet	Grey	16.9	36.2	0.4	2.8
550–560 feet	Grey, some white	6.0	48.4	0.4	0.8

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* The MgO content of each sample was determined by spectrochemical analysis. For those samples in which the MgO content exceeds 10 per cent. and for several in which the MgO content is less than 10 per cent., the MgO and other constituents were determined by chemical analysis.

† R_2O_3: Iron and aluminium oxides, with those oxides of titanium, zirconium, beryllium, chromium, five-valent phosphorus, arsenic, and vanadium. Usually for limestone R_2O_3 is essentially aluminium oxide, the remaining substances being present in very low percentages if at all.

‡ Insol.: Acid insoluble material; contains those minerals, chiefly silicates, that do not dissolve when heated with hydrochloric acid.

§ MgO less than 10 per cent. by spectrochemical analysis.

Analyses of Limestone, 900 Crosscut, Central Zeballos Mine—Continued.

Distance from Portal.	Colour of Limestone.	MgO.*	CaO.	R_2O_3.†	Insol.‡
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
560–570 feet	Grey	6.6	48.1	0.3	1.8
570–580 feet	Grey	§	......	......	......
580–590 feet	Grey	§	......	......	......
590–600 feet	Grey	§	......	......	......
600–610 feet	Grey	6.3	46.2	0.3	1.0
610–620 feet	Grey and white	7.5	47.2	0.3	1.5
620–630 feet	Grey	§	......	......	......
630–640 feet	Grey	8.9	45.7	0.2	0.6
640–650 feet	Grey	7.7	46.7	0.3	2.7
650–660 feet	Grey	5.9	48.8	0.04	3.2
660–670 feet	Grey and white	§	......	......	......
670–680 feet	Grey and white	§	......	......	......
680–690 feet	Grey and white	§	......	......	......
690–700 feet	White with grey	§	......	......	......
700–710 feet	Light-grey	§	......	......	......
710–720 feet	Light-grey	§	......	......	......
720–730 feet	Light-grey	§	......	......	......
730–740 feet	Light-grey	§	......	......	......
740–750 feet	Grey	§	......	......	......
750–760 feet	White	§	......	......	......
760–770 feet	White	§	......	......	......
770–780 feet	White with grey	§	......	......	......
780–790 feet	Grey and white	§	......	......	......
790–800 feet	Grey and white	§	......	......	......
800–810 feet	Light-grey	§	......	......	......
810–820 feet	Grey and white	§	......	......	......
820–830 feet	Grey	§	......	......	......
830–840 feet	Grey and white	§	......	......	......
840–850 feet	Grey	§	......	......	......
850–860 feet	Grey and white	§	......	......	......
860–870 feet	Grey	§	......	......	......
870–880 feet	Fairly white	§	......	......	......
880–890 feet	Greyish	§	......	......	......
890–900 feet	Grey and white	§	......	......	......
900–910 feet	Grey and white	§	......	......	......
910–920 feet	Grey and white	§	......	......	......
920–930 feet	Whitish	§	......	......	......
930–940 feet	Whitish	§	......	......	......
940–950 feet	White and grey	§	......	......	......
950–960 feet	White and grey	§	......	......	......
960–970 feet	White with black streaks	§	......	......	......
970–980 feet	Grey and white	7.0	46.9	0.4	2.4
980–990 feet	Limestone with silicate rock	§	......	......	......
990–1,000 feet	Limestone with silicate rock	§	......	......	......
1,000–1,010 feet	Grey and white	§	......	......	......
1,010–1,020 feet	Grey and white	§	......	......	......
1,020–1,030 feet	Limestone with silicate rock	§	......	......	......
Bluff at Portal of 900 Level.					
0–10 feet west of portal	Grey and white	§	......	......	......
10–20 feet west of portal	Grey and white	§	......	......	......
20–30 feet west of portal	Grey and white	§	......	......	......
30–40 feet west of portal	Grey and white	§	......	......	......
40–60 feet west of portal	Grey and white	§	......	......	......
For 30 feet east of portal	Grey and white	§	......	......	......

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* The MgO content of each sample was determined by spectrochemical analysis. For those samples in which the MgO content exceeds 10 per cent. and for several in which the MgO content is less than 10 per cent., the MgO and other constituents were determined by chemical analysis.

† R_2O_3: Iron and aluminium oxides, with those oxides of titanium, zirconium, beryllium, chromium, five-valent phosphorus, arsenic, and vanadium. Usually for limestone R_2O_3 is essentially aluminium oxide, the remaining substances being present in very low percentages if at all.

‡ Insol.: Acid insoluble material; contains those minerals, chiefly silicates, that do not dissolve when heated with hydrochloric acid.

§ MgO less than 10 per cent. by spectrochemical analysis.

CHAPTER V.—DESCRIPTIONS OF PROPERTIES.

PROPERTIES IN LOWER VALLEY OF THE ZEBALLOS RIVER, DOWNSTREAM FROM SPUD CREEK.

Answer. This group of claims, about 1 mile up the main road from Zeballos townsite, includes the Answer Nos. 1 to 6 mineral claims staked in 1937, brought to Crown grant in 1939, and owned by Zeballos Answer Gold Mines, Limited, c/o Whittaker & McIlree, 608–610 Central Building, Victoria. H. A. Heywood and associates drove the two adits on the property. The lower adit was extended 30 feet in 1939 by Zeballos Answer Gold Mines, Limited, incorporated that year to acquire the property. Since then no further work has been done on the property. No production has been recorded from the property.

The showing consists of a vein, strike northeasterly and dip vertical, and has been explored by two adits (Fig. 4), which are about 400 feet northwesterly from a point on the main road 1.1 miles from Zeballos Post Office (Fig. 2).

The rock in the adits is massive, dark-green tuff that is cut in places by dykes and irregular masses of fine diorite.

The vein, strike north 57 degrees east and dip 70 to 80 degrees northwestward, ranges in width from 0 to 2 inches but usually is about 1 inch and follows a shear zone 2 to 8 inches wide. The vein matter consists of quartz, calcite, and smaller amounts of pyrite.

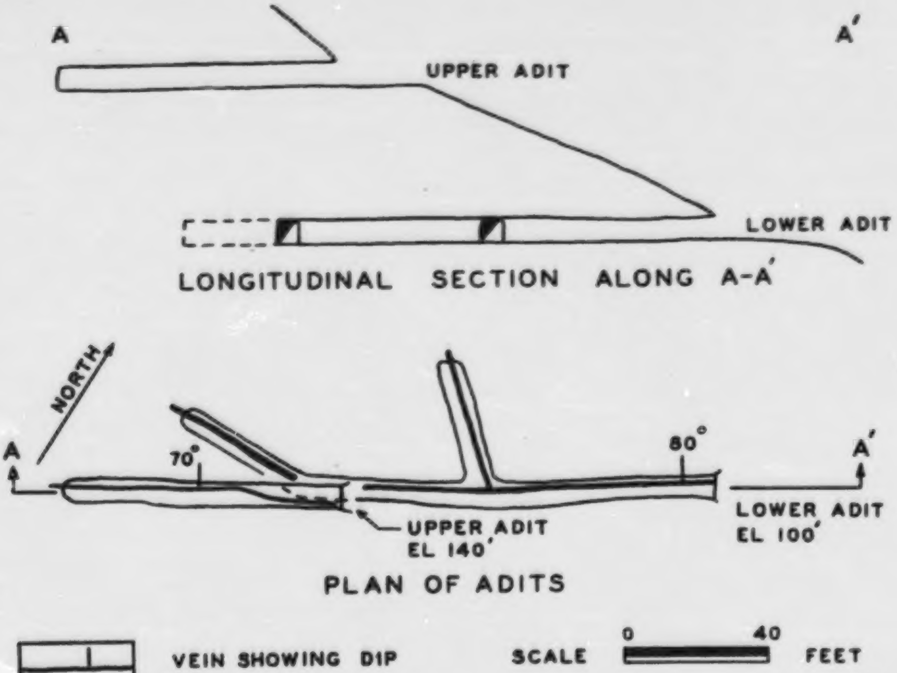

Fig. 4. Answer: Plan of workings and longitudinal section through vein.

Two adits, shown in plan and longitudinal section in Figure 4, have been driven on the vein. In the lower adit, a vertical branch fissure, strike north 35 degrees west and 62 feet from the portal, has been followed for 37 feet, in which distance it contains a few blebs of quartz. At 120 feet from the portal the adit leaves the original fissure to follow another branch fissure, 3 inches wide, strike east and dip vertical to 70 degrees northward. The quartz vein matter is fairly persistent along this branch fissure, but no vein matter is seen in the fissure at the face. It is reported that high assays in gold have been obtained along this branch vein.

In the upper adit the shear is along the southeast wall for 15 feet from the portal, then crosses the adit diagonally, and is on the northwest wall to the face. Quartz and calcite, 0 to 2 inches wide, follow the shear from the portal to the face but are absent at the face.

The vein is reported to have been traced southwesterly from the adit, but it cannot be traced northeasterly because of swamp and valley fill.

In 1938 Maconachie (Stevenson and Maconachie, 1938, p. 42) obtained the following assays from samples taken in the upper adit when it was in 13.5 feet:—

At portal plus 7 feet, across 3 inches of quartz with slight pyrite, in the face (April 10th, 1938): Gold, 1.20 oz. per ton; silver, 0.5 oz. per ton.

From portal plus 7.2 feet to portal plus 10.8 feet, over full width of fracture filling, ranging from 1 inch to 2 inches, and consisting of gougy, rusty calcite, a little quartz, one or two small patches of fine-grained, dark sulphides, and a slight amount of coarser sulphides, mainly pyrite (April 18th, 1938): Gold, 1.04 oz. per ton; silver, 0.6 oz. per ton.

From portal plus 10.8 feet to face at portal plus 13.5 feet, over full width of fracture filling, ranging from 1 inch to 2 inches and mineralized as the preceding sample: Gold, 0.3 oz. per ton; silver, 0.3 oz. per ton.

At portal plus 13.5 feet, over 2½ inches of calcite, a little quartz and slight visible pyrite, in the face (April 18th, 1938): Gold, 0.04 oz. per ton; silver, trace.

At portal plus 13.5 feet, over 18 inches on the footwall of the preceding sample, mostly barren greenstone with some calcite veinlets: Gold, *nil;* silver, *nil.*

Tagore.

One of the old properties in the district, the Tagore was first staked in 1924, restaked several times, the last being in 1945 when it was restaked as the Nayda Nos. 1 and 2 by D. T. Lutes and was owned by Tagore Mines, Limited. In September, 1946, the property was under option to Conquest Mines, Limited, 510 Dawson Building, Vancouver.

The vein on this property was discovered in 1924, and it and surrounding ground were intensively prospected in 1925, 1929, and 1932 to 1933, after which no further work was done on the property until 1938 when Tagore Mines, Limited, was incorporated. This company commenced a new shaft about 15 feet southwesterly from an old shaft, but work was suspended in 1940. The company sank the shaft 133 feet and erected the headframe on a concrete collar that extended 18 feet above bedrock to avoid the high waters of the Zeballos River during floods. At 87 feet below the top of the collar, a working was driven southwesterly from the shaft for 70 feet from which point two flat diamond-drill holes are reported to have been drilled, one hole about 38 feet in a northwestern direction, and another about 30 feet in a southeastern direction. This level also extends northeasterly from the shaft for 15 feet to a reference point "A," whence it goes westerly 20 feet and from the same reference point "A" it goes easterly 30 feet. At a depth of 140 feet a second level, the 140 level, was driven northeasterly from the shaft for 60 feet, northwesterly from the shaft for 30 feet, and then northeasterly for 10 feet. After 1940 water filled these workings and was not pumped out until February, 1947, when 55 feet of crosscutting and 80 feet of drifting were done on the 140 level. The writer has not examined this recent work.

The history of the property prior to 1932 and the workings at that time have been described in detail by H. C. Gunning (1932, pp. 37, 38), who examined the property when much of the early work was being done. These workings were badly sloughed and overgrown with bush when the writer visited the property in 1945 and therefore Gunning's description (1932, pp. 37, 38) of the older workings has been incorporated in this report:—

> The *Tagore* group of claims straddles Zeballos River about 1½ miles above its mouth. The vein is on the west bank of the river and was discovered in 1924 by J. West and A. Ostman. Known as the Eldorado at that time, it was systematically prospected and

abandoned by an English syndicate in 1925. In 1929 it was optioned as the Tagore, by A. B. Trites, from Messrs. Malmberg and Nordstrom, of Quatsino. About 2 tons of ore, unofficially reported to have assayed about 20 ounces in gold to the ton, was shipped, but apparently results were not satisfactory for the property lay idle until 1932 when Malmberg, Nordstrom, and four associates commenced mining on a small scale, under an agreement with A. B. Trites. By September a shipment of 4,500 pounds had been made and the smelter returns indicated an assay value of 2.63 ounces of gold and 2.52 ounces of silver a ton; a gross value at that time of $50.50 a ton. The property is on the main Zeballos River trail and accommodation consists of two small cabins and a blacksmith shed.

The vein consists of quartz or quartz and calcite with a small to very large proportion of pyrrhotite, zinc blende, chalcopyrite, galena, pyrite, and native gold. Pyrrhotite and zinc blende are most abundant, and pyrite and galena are very minor constituents. Native gold was seen only during microscopic examination of polished surfaces of the ores and then as small, scattered grains in sulphide or gangue. A very small amount of an unidentified grey mineral was also noted. The quartz is white and finely crystalline to coarse and vuggy. It is much more abundant than calcite which is quite locally, but in some places abundantly, developed. The vein has been followed for a total distance of about 50 feet and varies from a barren, tight fissure to an exceptional maximum width of about 15 inches. It trends north-east, along a well-defined fissure, and the dip is vertical. The rocks in the vicinity are Triassic flows, tuffs, limestone, and other sediments of the Bonanza group cut by a multitude of dykes and irregular bodies which vary from a very dark quartz gabbro containing abundant magnetite to light-grey and white micropegmatite. These Coast Range intrusives are very abundant for about one mile south of the property, but do not continue far to the north. The Triassic rocks are much contorted and somewhat faulted and generally have very steep dips.

The vein fissure cuts fine-grained, green, banded tuffs and crystalline limestone which strike 10 degrees north of east and dip very steeply north. Towards the north-east end of the vein these rocks are cut by a northerly trending diorite dyke, about 7 feet wide, which, on the west side, is partly replaced by white to light-grey quartz-augite-albitite. Within the limits of this dyke there is practically no ore in the fissure. The whole productive part of the vein is in the dense, brittle tuffs which have been extensively altered, in large part before the vein was formed, to garnet, epidote, and chlorite. Immediately north-east of the dyke the vein has been developed by a shaft to a depth of 15 feet. Just north of the dyke the vein was found to split into two parts, one continued north-east but died out within 8 feet, the other turned to 10 degrees north of east, approximately along the bedding, and had been followed for 14 feet at the time of examination. The vein pinched and swelled along this part, sometimes forming a narrow network of small veins in the volcanics, but, at the junction of the two parts, widths up to about 15 inches of good ore were encountered for a few feet. The vein continued 15 feet south-west of the dyke, in an open-cut, and then encountered altered crystalline limestone in which the ore soon ceased although the fissure continued. The limestone member is probably about 6 feet thick and dips steeply north; it was extensively altered to a mixture of garnet, diopside, quartz, calcite, and zinc blende, with some albite and apatite, before the vein was introduced, and, in heavily weathered portions, exhibits casts of fossils. No search has been made for the vein immediately south of the limestone, this part of the surface being drift covered, but the writer understands that some ore was encountered in the limestone immediately beneath a narrow lamprophyre dyke that strikes 13 degrees north of east and dips 36 degrees south, above the south end of the vein. Unfortunately the collar of the shaft is at the edge of the high water-level of Zeballos River, so that further development to the east would have to be well underground in order to avoid excessive inflow of water.

For several hundred feet to the south-east of this vein the ground was prospected by pits and open-cuts in 1925. Some low-grade, contact metamorphic mineralization, including considerable zinc blende, was found in the same types of rocks that are exposed near the vein, but no similar vein was encountered.

Examination of the ores under the microscope showed that the gold varied considerably in colour, probably because of a variable amount of silver alloyed with it, and that the tiny grains occur either in quartz, or in galena, or in sphalerite, or along the boundaries between different sulphides. It is definitely later than zinc blende, which it sometimes veins, and in all probability was one of the last minerals introduced. No gold was observed in the pure pyrrhotite which forms a considerable part of the ore. Some surfaces suggest, but do not definitely prove, that the precious metal formed at about the same time as chalcopyrite.

It is noteworthy that the vein cuts and is definitely later than the contact metamorphic zinc mineralization in the adjoining rocks.

A working at an elevation of 160 feet about 1,000 feet upstream and 150 feet north of Tagore Creek at the base of a rocky knoll 30 feet high is not described by Gunning.

The working consists of an open-cut 13 feet wide driven north 42 degrees east for 32 feet and an adit of the same width driven 10 feet from the end of the open-cut.

The rock is massive, green tuff and contains a limestone lens 3 feet long by 1 foot wide, which trends north 60 degrees west. A northwesterly trending granodiorite dyke 1 foot wide is exposed in the bluff above the adit. The tuff in the face of the adit has been brecciated by many small dykes of granodiorite.

A strong shear 1 foot wide, strike north 70 degrees west and dip 65 degrees northeastward, has been intersected by the adit 2 feet from the face, but it did not contain any mineralization.

The recorded production from the Tagore property includes 2 tons of ore shipped in 1929 (Gunning, 1932, p. 37), and reported to assay 20 ounces in gold to the ton, and includes other shipments in 1930, 1932, and 1939, which amounted to 16 tons of mined ore, and which contained in net amounts: Gold, 38 ounces; silver, 63 ounces; copper, 38 pounds; lead, 45 pounds.

Golden Portal (Golden Gate). This group includes the Golden Portal Nos. 1 and 2 mineral claims staked in 1945 by Olaf Torjusson and Seth Witten, and the Golden Gate and Golden Gate No. 2 claims staked in 1936 by D. T. Lutes and C. W. Smith; all are owned by Golden Portal Mines, Limited. This property covers, in part, ground formerly covered by the Golden Gate group of claims originally staked in 1936 and 1937.

As the claims have not been surveyed, the position of the workings, but not the outlines of claims, has been shown in Figure 2. The claims are west of the Prosperity claims and extend northerly from Golden Gate Creek to Hidden Valley Creek and from 500 to 5,000 feet easterly from the Zeballos River.

The first work, which consisted mainly of the open-cuts (Fig. 5) above the present adit, was done by the Golden Gate Zeballos Mines, Limited, a private company, in 1936 and 1937. The adit (Fig. 5) was started in 1938. From 1939 to 1945 little work was done on the property, but early in 1946 Golden Portal Mines, Limited, was organized, and this company continued the drift southerly to its present face, stopping work late in the same year.

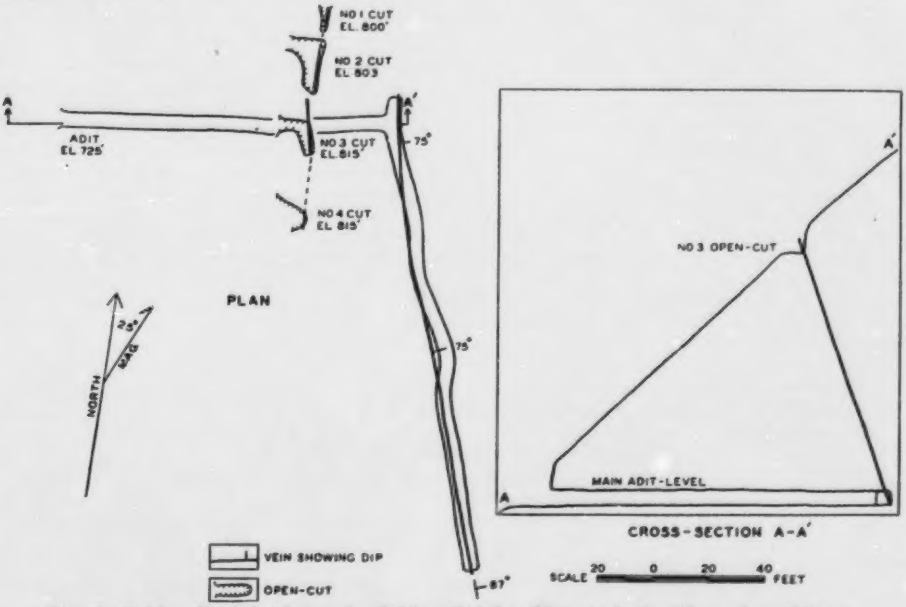

Fig. 5. Golden Portal (formerly Golden Gate): Plan and elevation of workings.

Recorded production amounts to 24 tons of ore shipped in 1940, which contained 12 ounces of gold and 5 ounces of silver, net. It is reported that a shipment was made in 1939 that consisted of 5 tons averaging $54 per ton.

The rock in the property is dark-green, massive andesite cut by many small dykes of fine-grained gabbro. Underground and in the open-cuts gabbro predominates.

The main showing on the property is a quartz vein that has been explored on the surface by open-cuts and underground by a drift 173 feet long. These workings are shown in plan and cross-section in Figure 5. Small pits, now sloughed, are reported to have traced the vein for an additional 300 feet southerly beyond the surface workings shown in Figure 5. Two pits, 750 feet upstream from the adit on the east side and 50 feet above the creek, have been sunk on a shear zone 1 foot wide, which is on the projected strike of the vein. The shear, which may be the same shear as in the adit, contains considerable rusty material and up to 3 inches of quartz.

In the drift and in the open-cuts above, the vein, strike north 10 to 20 degrees west and dip 71 degrees northeastward, is lenticular and ranges in width from 1 to 8 inches but never entirely dies out. It follows a well-defined shear zone usually only a few inches wider than the vein. The quartz contains pyrrhotite with small amounts of pyrite and chalcopyrite. The sulphides usually are in small amounts, but in some places they comprise 75 per cent. of the vein matter. Assays of vein matter on samples taken by the Department have ranged from a trace to 1.30 ounces of gold per ton.

Prosperity. This group of claims on Hidden Valley Creek includes the Prosperity Nos. 1 to 5, Prosperity Nos. 7, 10, and 11 Mineral Claims (Lots 1799 to 1805, inclusive, and L. 2046) staked in 1937 and owned by Zeballos Dome Gold Mines, Limited. These claims have been surveyed, and their position on Hidden Valley Creek is shown in Figure 2.

The showings consist of several narrow shear zones in andesitic tuff. Small open-cuts have been dug, and the positions of three of them, found by the writer in 1945, are shown in Figure 2.

The most northwesterly cut, at an elevation of 1,270 feet, has been driven north 21 degrees east for 8 feet to an 8-foot face along a shear zone 3 feet wide. The most northeasterly cut, 200 feet easterly along the hillside from the first cut, is in the bed of a small, southeasterly flowing creek and has been driven northwesterly 8 feet along a shear 3 feet wide. Some rusty sheared rock was seen in the shears in these cuts, but no quartz or sulphide mineralization.

The most southerly cut on the east bank of Hidden Valley Creek, 25 feet above the stream bed, is 6 feet wide and was driven 5 feet northerly to crosscut a shear a few inches wide that strikes east and dips 40 degrees northward. No mineralization was seen in the shear.

There may be other showings on Prosperity ground, but the writer could obtain no information about them.

An adit (Fig. 2) at 790 feet elevation was driven from the east bank of Hidden Valley Creek, presumably to intersect the downward extension of vein shears found somewhere on the hillside above, but no vein was found in the adit. A vertical fault, intersected in the face of the adit, contains a rusty seam but no mineralization. The adit was driven on a northeasterly course for 335 feet from the portal and then northerly for the last 25 feet. The rock in the adit consists of northwesterly striking lava and, at 110 feet from the portal, a 15-foot bed of limestone, strike northwesterly and dip vertical.

Van Isle. The Van Isle property on Van Isle Creek on the southeast side of the Zeballos River is owned by Privateer Mine, Limited, and is reported to consist of the following claims, which were Crown-granted in 1940: Van Isle No. 1 (L. 1744), and the Van Isle No. 2 (L. 1777) staked in 1933; V.I. No. 1

(L. 1786), V.I. No. 2 (L. 1787), V.I. No. 3 (L. 1791), V.I. No. 4 (L. 1788), and Cascade No. 2 (L. 1785) staked in 1937; and Blue Ox Fraction (L. 1783) and Hay Fraction (L. 1782) staked in 1938.

Until 1935 the workings consisted of open-cuts and strippings made by the original owners, Ray Pitre and associates. That year the property was bonded to the Nootka Gold Mining Syndicate, of Victoria, who commenced driving the 1800 adit east (Fig. 6) on the vein. In 1937 Man-of-War Mines, Limited, incorporated that year, acquired the property and continued driving the 1800 adit and started the 2000 adit. In 1939 Privateer Mine, Limited, the present owner, acquired the property and did further underground work.

Production from this property, principally from the stope above the 1800 level east, has amounted to 3,100 tons, containing 1,178 ounces of gold and 540 ounces of silver gross.

The camp (Fig. 2) is on Van Isle Creek about 1,000 feet by road from the main Zeballos River road, and the workings are upstream from the camp, the farthest adit being about 1,000 feet by trail from the camp.

The main workings and most of the ground covered by the claims are in an area of massive andesite tuffs with minor amounts of fine volcanic breccia, all of which strike northwesterly and dip steeply northeastward. These rocks are cut in a few places by feldspar porphyry dykes up to 5 feet wide.

Two main veins have been found on the property. One vein, strike north 43 to 50 degrees east and dip 70 to 80 degrees northwestward, has been explored underground by three levels for a total strike-length of 500 feet, and 400 feet vertically as measured from the surface above the 1800 adit to the 2000 adit. This vein has also been traced on the surface by widely spaced open-cuts for a further distance of approximately 1,400 feet southwesterly, making a total known strike-length of approximately 1,900 feet. The other vein, strike north 32 degrees east and dip 80 degrees northwestward, has been explored underground by a drift on the 2,000-foot adit for a length of 160 feet; it has not been crosscut on the upper adits.

The veins range in width from a knife-edge to 3 feet, but widths less than 1 foot are the more common. They follow well-defined shear zones a few inches wider than the veins that in some places pass along the strike into sheeted zones 4 feet wide. Most of the vein quartz is massive, but some of it is ribboned by streaks of fine-grained sulphides. The sulphides in the vein quartz include principally pyrite, galena, and sphalerite, but occasionally large patches of massive arsenopyrite and pyrrhotite are found. Patches of coarse-grained calcite also occur in the vein quartz.

The surface workings extend southwesterly from the level of the southwest fork of Van Isle Creek at 650 feet elevation up the steep, heavily wooded hillside to an elevation of 880 feet. The cuts had largely sloughed when the property was examined last, in 1945. However, they had been examined by the writer in 1938, and the following quotation is from a report (Stevenson, 1938, pp. 6, 7) made at that time:—

> The lowest cut, at an elevation of 780 feet, has been driven in a direction south 45 degrees west for 16 feet. The north-westerly wall of the cut shows a fractured zone 8 inches in width that contains at one place, 3 feet from the portal, a lens of quartz 8 inches long and 2 inches wide, the quartz containing scattered pyrite and arsenopyrite. A sample taken across this lens assayed: Gold, 0.22 oz. per ton; silver, trace. A thin lens of sulphide 1 inch thick and 2 inches long occurs in the floor on the south-easterly side of the cut. The face, 5 feet high, contains four equally spaced, tight joints striking south 45 degrees west and dipping 78 degrees north-westerly; the most north-westerly joint is a continuation of the fracture in the same wall, described earlier.
>
> South-westward, and 45 feet higher up the hillside, a showing under a tree-root exposes a lens of quartz 2 feet long and 8 inches wide. This contains very little sulphide, but lies between strong walls.
>
> Farther south-westerly along the strike and up the hillside at an elevation of 850 feet, a stripping 10 feet long exposes a strong shear ranging from 8 to 12 inches in width, and

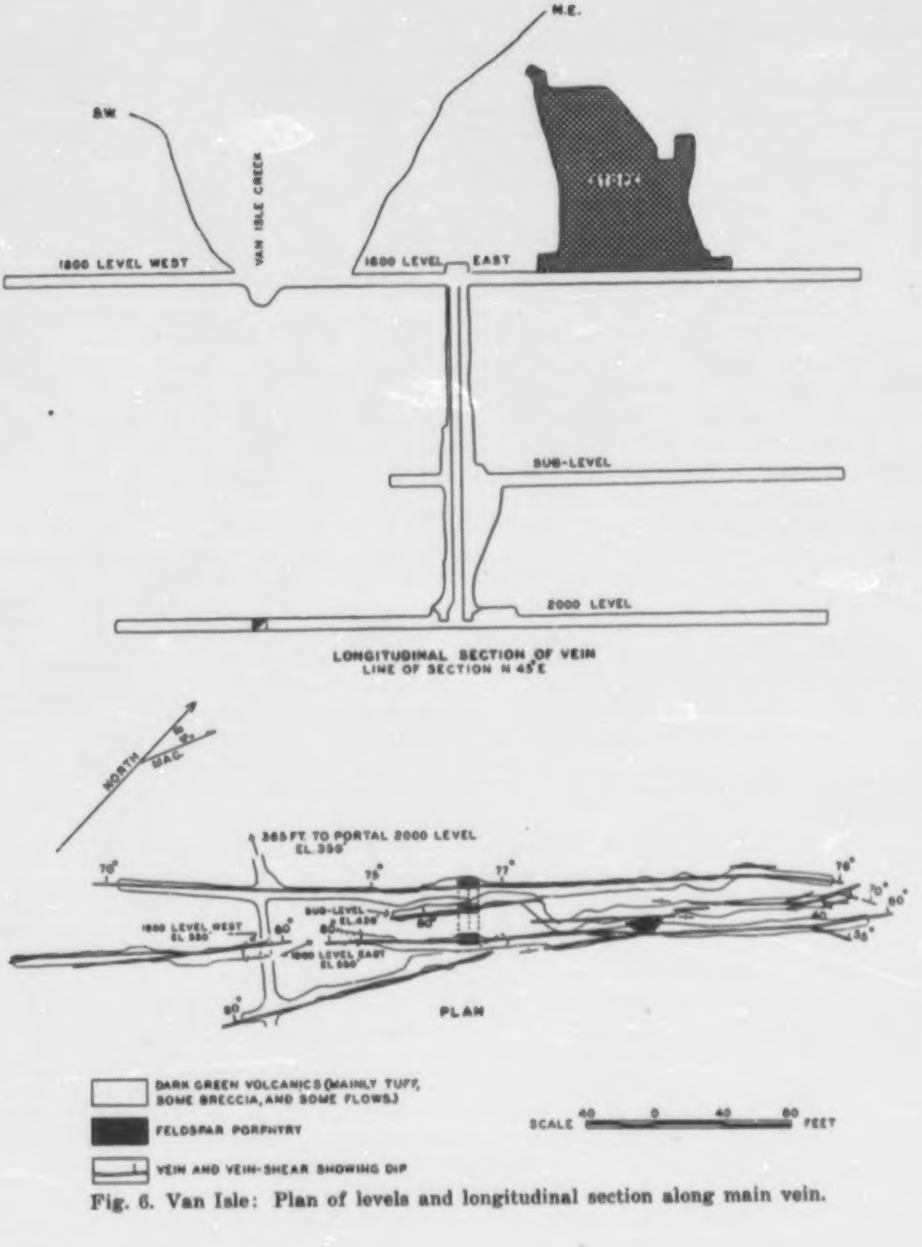
N.E.
S.W.
VAN ISLE CREEK
1800 LEVEL WEST
1800 LEVEL
EAST
SUB-LEVEL
2000 LEVEL
LONGITUDINAL SECTION OF VEIN
LINE OF SECTION N 45° E
NORTH
MAG.
365 FT. TO PORTAL 2000 LEVEL
EL. 350'
70°
75°
77°
76°
70°
80°
40
35°
SUB-LEVEL
EL. 430'
80°
1800 LEVEL WEST
EL. 380'
80°
80°
1800 LEVEL EAST
EL. 390'
90°
PLAN
DARK GREEN VOLCANICS (MAINLY TUFF, SOME BRECCIA, AND SOME FLOWS.)
FELDSPAR PORPHYRY
VEIN AND VEIN-SHEAR SHOWING DIP
SCALE
40
0
40
80
FEET

Fig. 6. Van Isle: Plan of levels and longitudinal section along main vein.

containing fragments of blue quartz that have been cut by numerous fractures paralleling the usual south-westerly strike of the shear. This quartz contains finely disseminated arsenopyrite. A sample taken across an 8-inch width of the best-mineralized portion assayed only traces in gold and silver.

The last working, a 15-foot stripping farther south-westward up the hillside, begins at an elevation of 880 feet, exposes a section of the shear, ranging from 10 to 12 inches in width, that contains numerous ½-inch stringers of both blue quartz and vuggy quartz; small amounts of pyrite and arsenopyrite were seen in the quartz. A sample taken across 10 inches of shear, where the quartz and sulphides, pyrite and arsenopyrite were heaviest, assayed: Gold, trace; silver, 0.4 oz. per ton; and one across 8 inches of crushed rock without any quartz or sulphides assayed traces only in gold and silver.

The crest of the hill is some 50 feet above this cut, the slope flattening for 200 feet and then sloping steeply westward.

In September, 1946, underground workings consisted of three adits (Fig. 6), 1800 west, 1800 east, and 2000 levels, a sublevel between 1800 and 2000 adits driven on the main vein, and a drift on the 2000 adit driven on the second vein. A raise has been driven from the 2000 adit to the sublevel and to the 1800 east, and a stope has been excavated on 1800 east (*see* longitudinal section, Fig. 6).

In 1800 adit east, the vein is 2 to 36 inches wide for approximately 240 feet from the portal. From that point to 270 feet it narrows to 1 or 2 inches, and from there to the face at 295 feet vein matter is lacking, but the shear 6 to 18 inches wide continues. In the face the shear contains a streak of coarse calcite 1 inch wide but no quartz. At 140 feet from the portal the vein leaves the northeasterly striking shear that it follows from the portal, and passing along two east-northeasterly striking diagonal breaks to another northeasterly striking shear follows it to the face of the drift. Between points 255 feet and 270 feet respectively from the portal, the vein is offset eastward by a series of diagonal joints, strike east and dip 60 degrees northward. The rock in the 1800 level east is mainly massive, greenstone tuff, but a tongue of feldspar porphyry is found on the northwest side of the drift between points 160 and 195 feet from the portal.

In the 1800 level west the vein shear, which is 8 to 12 inches wide, is persistent from the portal to the face, but vein quartz does not become continuous until 20 feet from the portal. With a width usually about 8 inches, it is continuous from here to the face, where it swells to 14 inches in width, and consists of 6 inches of ribboned quartz and 8 inches of massive arsenopyrite. At 30 feet from the portal a branch leads off at an angle of about 4 degrees, follows the southeast wall of the adit, and disappears in the wall about 40 feet from the face. The rock in this adit is massive andesite tuff.

The sublevel is irregular in plan and does not always follow the same vein fissure. For 85 feet the southwestern part of the drift follows the main vein, which is 6 to 8 inches wide and which lies between parallel walls. The vein is well defined along the drift. It is well exposed in the southwest face and also where the drift leaves the vein 85 feet northeast of the face. At this point the drift leaves the vein and follows a stringer of ribbon quartz 2 inches wide for 75 feet northeasterly, at which point the quartz narrows to 1 inch. The drift then swings northerly to follow what may be the continuation of the main vein. For about 60 feet northeasterly the vein is uniformly about 6 inches wide, but at 60 feet it branches. The several branches, consisting of 1 to 6 inches of quartz, are shown in Figure 6. At the face the quartz in the several branches is 1 inch wide, but the northern branch, which consists of an inch of quartz accompanied by a foot of sheared rock, appears to be following the principal vein shear.

In the 2000 level the vein is fairly continuous and is without pronounced bends or branches. For 150 feet northeasterly from the crosscut it ranges in width from 8 to 12 inches, but for the next 180 feet it is very lenticular, ranges in width from 0 to 6 inches, and is frequently only an inch wide. For 300 feet from the crosscut the vein shear is well defined and is a few inches wider than the vein, but for the next

30 feet to the face the shear becomes a sheeted zone about 4 feet wide, and the vein quartz, 2 to 6 inches wide (5 inches wide in the face), follows the most southeasterly of the joints in the sheeted zone. Southwesterly from the crosscut, the quartz is only one-quarter of an inch to 3 inches wide, but in the face it is 10 inches wide. In this drift the wallrock beside the vein shear is well sheeted.

A second, shorter vein lies southeasterly from the main vein, and with a strike of north 32 degrees east it is at an angle of about 15 degrees to the main vein and might be expected to intersect the main vein about 30 feet from the northeast face of the drift on that vein, but no such vein is seen in the walls of the drift at or near the proper place. No faults are evident in the main drift and it is most probable that the vein or vein shear in the shorter drifts died out in a northeastern direction.

For most of the distance along the drift the shorter vein is fairly continuous and ranges in width from 3 to 10 inches, but at a point 35 feet from the northeastern face the quartz narrows to several stringers half an inch wide, and at the face there is a stringer of quartz one-quarter of an inch wide; the vein shear narrows with the quartz. In the southwest face the quartz is 1 inch wide and the vein shear is 12 inches.

The rock in the drifts and in most of the crosscuts on the 2000 level is massive andesite tuff, but near the portal it is a fine volcanic breccia, strike northwesterly and dip steeply northeastward.

Plate XII. Privateer camp, looking northwesterly across Zeballos River up Maquinna Creek.

PROPERTIES ON SPUD CREEK.

Privateer.* This mine on Spud Creek is owned by Privateer Mine, Limited; company office, 602 Stock Exchange Building, Vancouver; mine office, Zeballos; D. S. Tait, president; N. E. McConnell, managing director; C. Harry Hewat, manager. The property consists of the following Crown-granted mineral claims: Privateer (L. 1040), Privateer No. 2 (L. 1697), Privateer No. 3 (L. 1041), Privateer No. 4 (L. 1696), Privateer No. 5 (L. 1742), Privateer No. 6 (L. 1743), Privateer No. 7 (L. 1042), Progress No. 1 (L. 1061), Progress No. 2 (L. 1062), Progress No. 4 (L. 1064), Pilgrim Extension (L. 1043), Riverside (L. 1781), Jay Fraction (L. 1789), and the Small Fraction (L. 1790).

History and Production.—The original company was incorporated in January, 1937, as the private company known as Nootka-Zeballos Gold Mines, Limited, but late in that year the name was changed to Privateer Mine, Limited, and in September, 1938, it was changed from a private to a public company. Later that year a one-quarter interest was acquired by Conwest Exploration Company, Limited.

No. 1 vein, found in 1936, is reported to have given "returns from bronzy pyrite of 55 ounces gold to the ton" (Bancroft, 1940, p. 10). In 1936 and 1937 the vein was opened by strippings and open-cuts and several tons of high-grade ore was shipped to Tacoma from these surface workings. Underground work was started in 1937, first on the 900 level and then on the 1000, and by the end of 1938 work had been started on all the levels above the 1100. The three-compartment shaft from the 1100 level started in 1939 had reached 128 feet by the end of the year and was completed to the 1300 level in 1941. In 1939 work was started on the 800 adit on No. 2 vein, which had been developed originally by the crosscut from the 900 level, and in 1940 further work was done on the No. 2 vein on Nos. 1000, 1100, 1200, and 1300 levels.

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* *See* Figures 7 to 10, inclusive, in pocket and Figures 11 and 12 in text.

Plate XIII. Privateer mill—track on right leads from 1100 level to coarse-ore bin, track on left carries waste from picking belt to dump.

In 1941–42 the long crosscut on the 600 level between Privateer and Prident was driven, and a raise was driven to the 600 level of the Prident mine.

An amalgamation-cyanide mill with a daily capacity of 90 tons was built in 1938, and milling was started in September of that year.

In October, 1943, Privateer closed, but in November, 1945, the company resumed mining and milling until the cessation of operations late in 1948. In May, 1946, the power-house burned, which suspended mining and milling for several weeks during the summer until it could be rebuilt and machinery installed.

Production and operation data for the entire life of the mine are set forth in the following table. Of the ore mined, 25 to 48 per cent. was sorted to waste before going through the mill.

Production and Operating Data, Privateer Mine.[1]

	Ore mined.	Ore treated.	Gold. Gross.[2]	Silver. Gross.[2 3]	Daily Tonnage milled.[4]	See Footnotes.	OPERATING COSTS PER TON OF ORE MILLED.[5]		
							Development and Exploration.[6]	Mining.	Milling.
	Tons.	Tons.	Oz.	Oz.			$	$	$
1934	8[7]	....	85	43	—	3	......	......	......
1935	4[7]	....	55	14	—	3	......	......	......
1936	2[7]	....	58	19	—	3	......	......	......
1937	422[7]	....	2,805	1,289	—	3	......	......	......
1938	45,289[8]	9,214	16,023	5,777	75	....	1.62	3.32	2.73
1939	38,262[9]	26,820	32,987	12,065	76	....	2.698	4.27	2.69
1940	46,148[9]	28,104	28,416	11,989	83	10	......	......	......
1941	51,831[9]	29,181	24,328	9,271	86	11	2.92	5.88	2.09
1942	41,205[9]	21,402	17,219	5,980	70	11	0.98[4]	5.68[4]	2.80[4]
1943	12,397[9]	8,850	9,727	3,254	44	11	1.95	6.35	4.96
1944	12	12	22	74	—	3 13	......	......	......
1945 (no production)	....	....	....	....	....	....	......	......	......
1946	7,045[9]	3,661	1,801	898	34	....	......	......	......
1947	21,128[9]	12,800	10,822	5,296	40	3 11	2.53[4]	7.19[4]	2.86[4]
1948	21,920[9]	13,300	10,023	4,913	12	11 14	......	......	......
Weighted average[15]	....	....	....	....	....	....	2.11	5.48	2.36
Totals	285,771	153,332	154,381	60,878	....	....	......	......	......

[1] Information, except where noted, from Yearly Summary Reviews of the Gold Mining Industry of Canada, published by Dominion Bureau of Statistics, Ottawa.

[2] Total metal content in crude ore and bullion as determined by settlement assay.

[3] Information from British Columbia Bureau of Economics and Statistics and British Columbia Department of Mines.

[4] Data from annual report of company to shareholders, and includes tonnage from Van Isle operation in 1940 and from Prident operation in 1941–1943 and 1947.

[5] Figures do not include taxes or marketing, head office, depreciation, and depletion charges but do include costs for Privateer, Van Isle, and Prident operations.

[6] Exclusive of outside operations.

[7] Crude ore shipped to smelter, figures for amount of sorting not available.

[8] As milling did not start until September, 1938, part of this ore was sorted and shipped to the smelter, and the remainder sorted to 9,214 tons and milled.

[9] Mine-run ore, includes waste discarded on picking-belt.

[10] Deduction made in production for ore trammed to Privateer mill from Van Isle or Man-of-War operation.

[11] Deduction made in production for ore trammed to Privateer mill from Prident operation.

[12] Data not available.

[13] Precipitates and residues.

[14] Data from correspondence, Privateer Mine, Limited, figures do not include amounts of gold and silver to be realized from clean-up of mill.

[15] Weighted for variation in yearly tonnage, including Van Isle and Prident.

Workings and Plant.—The mine has been developed by seven adits (Fig. 7), 600, 700, a southern 800 on No. 1 vein, a northern 800 on No. 2 vein, 900, 1000, and 1100, and by two other levels, the 1200 and 1300, which are connected to the 1100 adit by a three-compartment internal shaft. The 1100 adit is the main haulage level, ore being delivered from the upper adits to the 1100 by ore-passes and hoisted in the shaft from the lower levels. An inclined surface tramway that extends from the portal of the 1100 level to the portal of the 600 level formerly carried ore from the upper levels and from the Prident mine through the 600 crosscut to the mill level at 1100, but now it is used only as a service tramway. The ore is trammed directly to the coarse-ore bin at the mill, whence it passes through a grizzly to a picking-belt and into the mill-circuit where the gold is recovered by amalgamation and cyanidation and converted to bullion.

Power for the mine, mill, and camp is supplied by diesel engines.

As part of the exploratory work on the veins, a large amount of diamond drilling was done underground and on the surface. Drilling from the surface on the Privateer and Privateer Nos. 2, 3, 4, and 7 claims amounts to thirteen holes totalling about 5,600 feet and, from underground, forty-nine holes totalling about 10,500 feet.

Rock Types.—The Privateer veins cut massive volcanic rocks, a band of lime-silicate rocks, and small bodies of quartz diorite. The trend of all the rocks is in general northerly and the dip steeply westward or vertical. The distribution of the different rock types on the surface is shown in Figure 8, and their distribution underground is indicated by a geological plan of the 1000 level (Fig. 9) and in the longitudinal projections on Nos. 1 and 2 veins (Figs. 10 and 11).

Dark, brownish-green, massive volcanics without any apparent structure are found in the portal sections of the 900, 1000, and 1100 levels. In thin sections the rocks are seen to be fragmental and appear to be crystal tuffs of andesitic composition. Farther in the mine, similar rocks, interbedded with lime-silicate rocks, occur as bands a few inches to 10 feet thick and as thin streaks and short curved lenses a few inches thick and a few feet long. The curved lenses appear to be the thicker parts along the crests of dragfolds and the thinner streaks the limbs of dragfolds.

The lime-silicate rocks include laminated and banded rocks ranging from grey to cream and light green and consist of the lime-silicate minerals diopside, wollastonite, lime garnet, lime plagioclase, plus quartz and biotite; these rocks are interbanded with a few narrow bands of brown fragmental volcanics.

In places the brown volcanics have altered to a striking apple-green rock consisting predominantly of diopside. The detailed description of this alteration has been given on pages 26 and 27.

Quartz diorite is the principal intrusive on the property. Although the main mass of quartz diorite lies east of the workings (6, Fig. 2), many smaller bodies have been intersected underground and found in outcrop (Figs. 8–11). On Lot 1040 about 600 feet southwest of the main mass a large lenticular body of quartz diorite, about 2,000 feet long with a maximum width of about 300 feet, trends northerly and dips westward. A smaller lenticular body about 800 feet long and up to 50 feet wide and several more dyke-like bodies underlie and lie east of the large lens. In a few places the dykes and stringers of quartz diorite are so numerous and closely spaced that the rock-mass is locally a breccia. In general, the lenticular bodies of quartz diorite trend conformably to the strike of the sediments but in places cut them at a small angle. Most of the side dykes also cut the sediments at small angles, but a few cut the formation at moderately large angles.

The form and structure of the large lenticular body of quartz diorite is imperfectly known. It is exposed on the surface and on all the levels from the 600 to the 1200 but has not been found on the 1300 level (Figs. 10 and 11). Three reasons of different degrees of probability may be given for the absence of the quartz diorite on this level:—

(1) Below the 1200 level the dip of this northerly trending body of quartz diorite may be flatter than that found between the upper levels; therefore, the quartz diorite body may lie ahead or to the west of the face of the drift on the 1300. This condition would be true if the quartz diorite occupied a break or zone of weakness that changed its dip between the 1200 and 1300 levels; however, such a rapid change in the dip of a wide

fracture zone is improbable. If the dip of the quartz diorite conforms with the dip of the sediments, some indication of the necessary flattening in dip should be noticeable in the lime-silicate rocks in the drift on 1300, but on this level the dips are steeply westward as in the upper levels.

(2) The downward extension of the quartz diorite could be cut off by a fault of low westward dip. However, as no such fault has been seen, nor is the vein on 1300 level offset in a manner that would be expected were such a fault present, this hypothesis is also improbable.

(3) The quartz diorite may be a pod-shaped body striking northerly and dipping from 30 to 60 degrees westward and with a southern (lower) edge plunging about 20 degrees northerly and a northern (upper) edge plunging much more steeply southerly. The strike may be seen in plan (Fig. 8) and the dip in the longitudinal sections on most of the veins (Figs. 10 and 11). The plunge of the southern edge is given by the plunge of the line, 20 degrees, joining the southern end of the outcrop 1,100 feet south of No. 1 vein (Fig. 8) with a point along the southerly edge of the pod where it intersects the plane of No. 1 vein between 1200 and 1300 levels (Fig. 10). An edge plunging northerly would account for the absence of quartz diorite from the 1300 drift on No. 1 vein and the presence of quartz diorite on 1300 drift on No. 2 vein.

The plunge of the north edge of the lens or pod of quartz diorite is less well known. As it is unlikely that the quartz diorite would develop from the sediments with no connection to an underlying parent batholith, it is implied that it extends downward to a parent batholith. Furthermore, as the quartz diorite is close to the northern end of the main batholith, the plunge of the body as a whole, if northward, would be much steeper than the plunge of 20 degrees north shown by the southern edge of the quartz diorite. Consequently, the plunge of the northern edge of the quartz diorite would be somewhere between the unlikely plunge of 20 degrees northward and a steep southern plunge. The limit of the southern plunge may be inferred from the plunge of a line joining a point at the north end of the outcrop of the large lens of quartz diorite (Fig. 8) with a point at the western end of 1202 level or drift on No. 2 vein (Fig. 11), a point known to be in quartz diorite. The plunge of this line is 30 degrees southerly. As this point is a considerable, though unknown, distance from the north edge of the quartz diorite, the plunge of the north edge of the quartz diorite must be considered greater than 30 degrees southerly and may be vertical or even steeply northerly.

This hypothesis of a pod-shaped body of quartz diorite striking northerly and dipping 30 to 60 degrees westward, with a gently plunging south edge and a steeply plunging north edge, appears to be the only one in accordance with the data available in September, 1946. Future underground work or diamond drilling may give more data.

An indirect substantiation of the last hypothesis is the parallelism between the gentle plunge of the south edge of the quartz diorite and the plunge of a line connecting the bottom of the ore in No. 1 vein with the bottom of the ore in No. 2 vein, 80 feet lower than No. 1 vein. Such a parallelism would be expected if the bottom of the oreshoots in the two veins were spatially related to the southern edge of the quartz diorite.

The rock in the lenticular bodies of quartz diorite is uniformly medium grained, black and white, massive, lacks any directional structures, and is mineralogically similar to that in the main mass of quartz diorite. Dykes a few inches to 2 feet wide are lighter in colour and have a higher content of orthoclase feldspar than the usual quartz diorite, thus resembling granodiorite or quartz monzonite in composition. They cut the quartz diorite, but the light-coloured rock is seldom in clean-cut, dyke-like relation to the quartz diorite and, although slightly younger than the darker quartz diorite, probably were formed before complete consolidation of the quartz diorite had occurred.

Both smoothly elliptical and sharply angular inclusions are found in the quartz diorite, but neither type is abundant. The smoothly elliptical inclusions were caught up in the quartz diorite at a considerable depth during an early stage in its emplacement. The sharply angular inclusions are of the immediate wallrocks, brown volcanics, and the lighter-coloured lime-silicate rocks that were engulfed by the quartz diorite at a fairly late stage in its cooling history. The angular inclusions had already acquired their present altered composition when they became engulfed in the quartz diorite. Possibly the alteration resulted from the heat of an earlier intrusion or from a hot stage immediately preceding the emplacement of the present body of quartz diorite.

Numerous, brown, biotized diabase dykes, 1 to 20 feet wide, cut the sediments and volcanics, but not the quartz diorite. Nearly all the narrower dykes, 12 to 18 inches wide, strike north 45 to 60 degrees east and dip steeply southeastward, whereas the wider dykes strike in several directions from north 20 degrees west to north 70 degrees east and all dip steeply. The diabase dykes are most numerous on the 1100, 1200, and 1300 levels, less numerous on the 1000 and 900 levels, and absent on the 800 and 700 levels. They are lenticular, short, and discontinuous, and it is impossible to correlate many of the dykes between the different levels. They are similar in appearance to the volcanics and can be recognized only where they cut across the bedding of the lime-silicate rocks. Although they are mineralogically similar to the volcanics, the dykes possess a diabasic texture that is in contrast to the fragmental texture of the volcanic tuffs. Where they cut bands of garnet-rich sediments, they are partly altered to light-green rocks that consist principally of diopside. The dykes cut the dragfolded sediments and are therefore younger than the dragfolding. The diabase dykes do not cut the quartz diorite and are assumed to be older than the quartz diorite. A single, light-coloured, post-quartz diorite dyke was seen cutting a diabase dyke.

A feldspar porphyry dyke about 1 foot wide, strike northwesterly and dip vertical, cuts the sediments on the 1000 level about 30 feet west of the main fault. It consists of feldspar phenocrysts one-eighth to one-quarter of an inch long set in dark-coloured fine-grained groundmass.

Light-coloured, porphyritic dacite dykes a few inches to 10 feet wide, characterized by closely spaced joints, cut the quartz diorite and the older rocks. They consist of phenocrysts of andesine, quartz, and some hornblende in a finer-grained, diabasic groundmass of andesine laths and small hornblende grains, and occasional titanite grains.

Although most of the dacite dykes are east of the large lens of quartz diorite, one dyke 6 inches wide was found west of it.

Folds.—The band of lime-silicate rocks and crystal tuffs that extends northerly from the Mount Zeballos mine to the Privateer and northwesterly to the Maquinna is folded at the Privateer into a trough plunging steeply southwestward (Fig. 2). Minor westward-plunging troughs in this major trough are outlined underground at the Privateer by local variations in strike, with the dip always southwestward.

Superimposed on the trough are two main and several smaller dragfolds with approximately vertical axial planes striking north 15 degrees west to north 10 degrees east and with nearly horizontal crest-lines. The two main dragfolds are on the west side of the large lens of quartz diorite (Fig. 10).

Smaller dragfolds, strike northwesterly to northeasterly and dip about vertical, are found throughout the mine in sediments and volcanics where these two main types of stratified rocks are interbedded. These folds are too small to be shown individually on the plan or profile at the scale of Figures 9, 10, and 11, but the position of many of them on the 1000 level has been shown diagrammatically in Figure 9. The folds are recognized only where brown volcanics are present.

Complete dragfolds are often seen on the walls of a working, but more often only the crests are found as crescent-shaped replacement remnants of a folded bed of brown volcanics (Plate VIII). The portion of the bed on the limb of the fold, granting that the folding was similar rather than the less common parallel or concentric type, was thinner than the crest or trough portion of the dragfold and was therefore more readily and more completely replaced by lime-silicate minerals.

During the period of deformation of the rocks, the thinly bedded brown volcanics and cream-coloured lime-silicate rocks constituted an incompetent group of beds that was dragfolded, whereas the massive, uniformly cream-coloured rocks constituted a competent group that was not dragfolded, even though subjected to the same stresses.

All the smaller dragfolds are closely compressed and resemble isoclinal folds in their tightness. A good example of an isoclinal fold is seen in the 1100 level along the drift on No. 1 vein in a garnet band 10 feet west of the main crosscut between Nos. 1 and 2 veins. Five feet from the trough of the fold the spread of the limbs is only 1 foot. Most of the smaller dragfolds are similar in size or even smaller.

The larger dragfolds are more open, and the distances from crest to crest measurable in tens of feet rather than in a few feet. The double fold west of the large lens of quartz diorite (Fig. 10) measures 200 feet horizontally from crest to crest and about 60 feet vertically from crest to trough.

The dragfolds are cut by diabase dykes and were, therefore, formed before the emplacement of the dykes. The dykes do not extend into the near-by quartz diorite and therefore are presumed to be older than the quartz diorite. This evidence indicates that the dragfolding was not an immediate accompaniment of the intrusion of quartz diorite batholith.

Veins.—A large number of quartz veins has been found on the property; three have produced most of the ore. Some features of texture and mineralogy are common to many of the veins and will be described before details of each vein are given.

Alternate bands of quartz and of sulphides mark the veins, but in places where they are not banded, vugs, from 1 inch to 1 foot in diameter lined with well-shaped crystals of quartz, characterize the veins. A comb texture develops where quartz crystals grow perpendicular to the walls and extend across and almost fill an opening, which may be either a vein or a fracture in older vein quartz. The part unfilled by quartz is often filled with sulphides grown around the ends of quartz crystals.

Where the vein quartz lacks sulphides it usually contains inclusions of wallrock. The inclusions are sharply angular and may be slightly altered, thoroughly bleached, or may be small, shadowy, triangular areas representing inclusions completely replaced by the vein quartz. The concentration of the inclusions is variable. In places only one or two are found for a distance of several feet; in other places they are so numerous that they comprise a closely packed rubble in the vein.

The quartz is variable in appearance. Where essentially without sulphides it is massive and milky white (Plate IX), but where it has replaced numerous wallrock inclusions the quartz is blotchy and murky grey. Where sulphides are present, in small or large amounts, the quartz is usually visibly crystalline. The crystals may be separated by sulphides, giving rise to vein matter that is very friable and may be shattered by a light blow with a hammer.

Ankerite is moderately abundant in all the veins, but in No. 1 vein is present only on the 1200 and 1300 levels. Coarsely cleaved ankerite with cleavage faces up to 2 inches across occurs in the middles of the veins and fills the spaces around the ends of quartz crystals. Some ankerite also lines vugs in the veins in the form of crystals up to three-quarters of an inch in size.

Calcite is found in late veinlets in the veins, in wallrock, and in the crush zones of some of the larger faults.

Although, locally, sulphides may be abundant, sparse, or absent, the productive parts of the veins are characterized by abundant sulphides. The sulphides include, in order of abundance, pyrite, sphalerite and galena, arsenopyrite, and pyrrhotite. Pyrite, sphalerite, and galena commonly are found together, the sphalerite and the galena in much smaller amounts than the pyrite. Where sphalerite and galena are sufficiently abundant, the texture of the sulphides is definitely banded and crustiform. Sphalerite and galena are usually towards the centre of the veins and therefore late in the mineral sequence of deposition. Arsenopyrite rarely occurs in parts of the veins where pyrite, sphalerite, and galena are abundant. Commonly it is found with dark-grey quartz as a layer near each wall of a vein where it is in fine needle-like crystals intergrown with quartz crystals, all perpendicular to the vein walls. Pyrrhotite is not widespread throughout the veins but, where it occurs, is in conspicuous masses up to a few inches thick by as much as 3 feet long. It is usually associated with about an equal amount of pyrite and with a little sphalerite and chalcopyrite.

The banding of the different vein minerals indicates that they have been deposited in the veins in successive periods of time. In any one fracture the minerals in bands closest to the walls were deposited earliest and those in bands towards the centre were deposited latest. It often happens that after a fracture has been filled with minerals, movement along the vein opens up a later fracture that may follow the central part of the vein or may weave along the vein. This later break becomes filled with a banded succession of the same minerals that occur in the older vein.

In the wider veins, which show a fairly complete succession of minerals, the order of deposition appears to have been, from oldest to youngest: the gangue minerals, including massive white and grey quartz that replaces inclusions of wallrock, crystalline quartz, and ankeritic carbonate; and the sulphide minerals, in order of deposition, pyrrhotite, arsenopyrite, pyrite, sphalerite, chalcopyrite, galena, and gold. Stringers of very late calcite occasionally cut the vein, but this material is not related to the main period of mineralization and may have been leached from the wallrocks.

The only changes that have been recognized in vein matter on the deeper levels are an increase in wallrock inclusions and vein carbonate and a decrease in sulphide content, particularly noticeable on the 1200 and 1300 levels.

No. 1 Vein.—No. 1 vein was the first to be mined and so far has produced the most ore. Although the vein generally strikes easterly and dips steeply northward, variations in strike and dip are noticeable (Fig. 7). The western end of the vein strikes north 66 degrees east, and from the upper levels to the 1000 level it dips 65 degrees northwestward, but below this level the vein is about vertical. The central section strikes north 83 degrees east and is vertical and the eastern section strikes north 67 degrees east and is mainly vertical. The greatest strike-length attained by the workings on this vein is about 1,450 feet, and the greatest drift-length on any one level is 1,060 feet on the 1100 level. The vein has been developed to a depth of about 1,000 feet as measured from the outcrop 150 feet above the 600 level to the lowest level, the 1300. It has been largely stoped above the 1100 level and partly stoped between the 1200 and 1100 levels (Fig. 10).

The vein quartz ranges in width from a fraction of an inch to the maximum of 4 feet. Despite this rather extreme range in width, the vein is not markedly lenticular but is generally tabular and usually ranges in width from 6 to 11 inches, with the average width nearer 11 inches. It follows a shear zone a few inches to 30 inches wide but in many places is accompanied by only a film of gouge along its walls. In the quartz diorite the vein shear commonly passes into a sheeted zone along its strike and the vein matter then follows one or more of the joints of the sheeted zone.

No. 2 Vein.—The second most productive vein on the property is the No. 2 vein. It is 260 feet north of No. 1 vein on the 800 level and 200 feet north on the 1300 level, strikes north 83 degrees east, and dips 86 degrees southward. Drifts have been driven on it on the 800 level and on all lower levels. All except the adit drift on the 800 level were developed from crosscuts from the drifts on No. 1 vein (Fig. 7). The vein has been developed for an over-all strike-length, as measured from the farthest westerly to

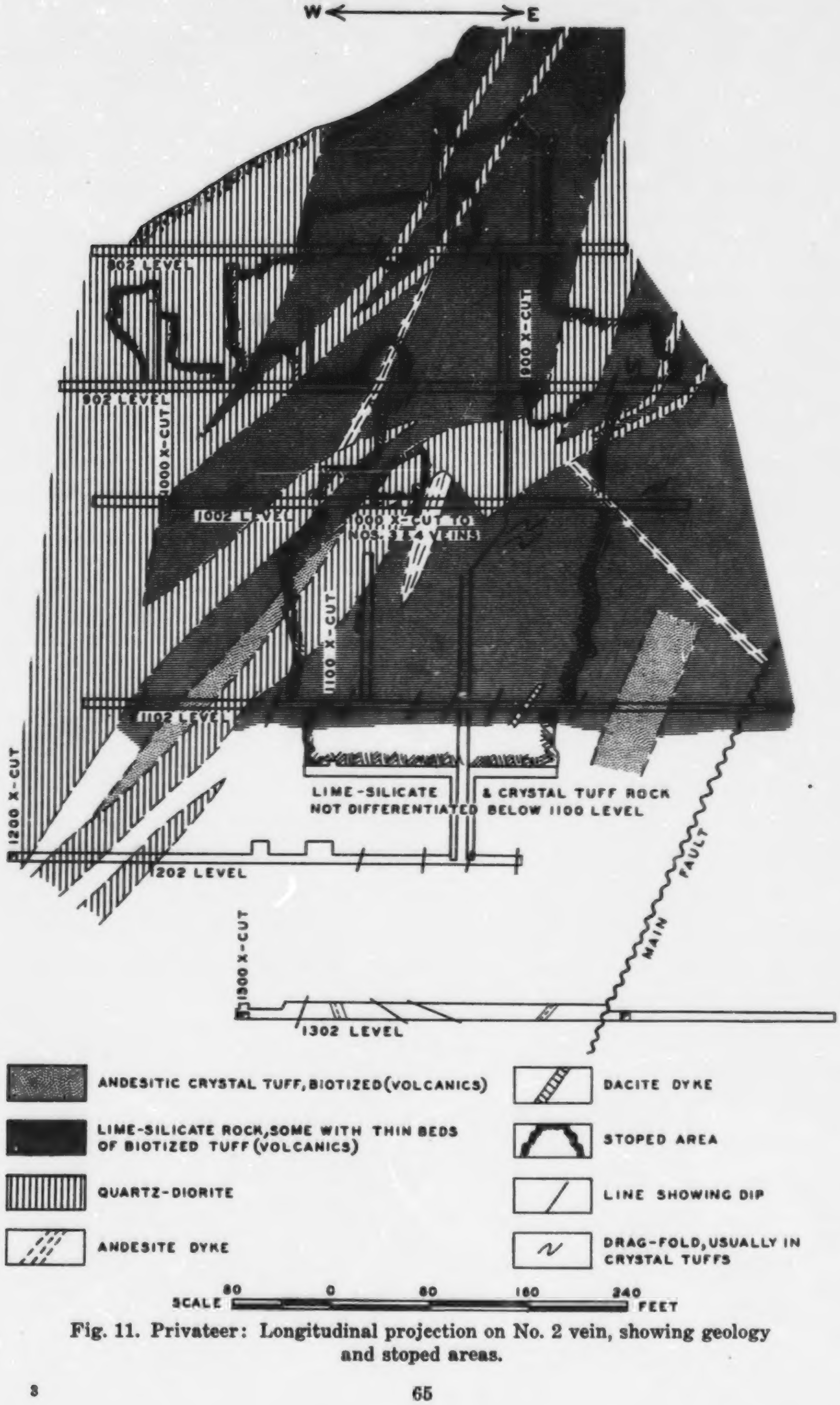
W
E
802 LEVEL
902 LEVEL
900 X-CUT
1000 X-CUT
1002 LEVEL
1000 X-CUT TO NOS. 3 & 4 VEINS
1100 X-CUT
1102 LEVEL
LIME-SILICATE & CRYSTAL TUFF ROCK
NOT DIFFERENTIATED BELOW 1100 LEVEL
1200 X-CUT
1202 LEVEL
MAIN FAULT
1300 X-CUT
1302 LEVEL
ANDESITIC CRYSTAL TUFF, BIOTIZED (VOLCANICS)
LIME-SILICATE ROCK, SOME WITH THIN BEDS OF BIOTIZED TUFF (VOLCANICS)
QUARTZ-DIORITE
ANDESITE DYKE
DACITE DYKE
STOPED AREA
LINE SHOWING DIP
DRAG-FOLD, USUALLY IN CRYSTAL TUFFS
SCALE
80
0
80
160
240
FEET

Fig. 11. Privateer: Longitudinal projection on No. 2 vein, showing geology and stoped areas.

the farthest easterly drift face, of 680 feet and has been developed for 840 feet down the dip from the top of the stope on the 800 level to the floor of the 1300 level. The area developed by drifts in the plane of the vein (Fig. 11) is approximately 373,000 square feet, and of this area about 124,000 square feet, or roughly one-third, has been stoped (Fig. 11).

No. 2 vein, which ranges in width from a few inches to 14 inches and is usually about 8 inches wide, tends to be narrower than No. 1. It possesses structural, textural, and mineralogical features similar to those of No. 1 vein; the same variations in vein matter are noticeable below the 1100 level.

Extremities of Nos. 1 and 2 Veins.—Drifts have been driven westward and eastward on both veins for a few tens of feet beyond stoped areas. In most of the drifts at the west ends of Nos. 1 and 2 veins the quartz has narrowed gradually to 3 or 4 inches within about 100 feet of the face and to 1 inch in the face, and in some faces vein matter is absent. In the volcanics and lime-silicate rocks only a 1-inch shear is present, and in the quartz diorite only a sheeted zone composed of several gouge-filled joints.

Easterly from the stoped areas on some of the levels the vein matter is sub-commercial. Between the 900 and 1100 levels on No. 1 vein mineable ore has been cut off by the Main Fault (Fig. 10), but where the vein was found east of the fault, it was sub-commercial. The vertical displacement of the fault is unknown. The ore that was being mined in 1946 on the 1100 and 1200 levels east of the Main Fault belongs to veins or branches of veins close to, but not actually, No. 1 vein.

It may be noted that the east end of some stopes on No. 1 vein are from 50 to 250 feet short of the fault. In most of these sections the vein is well defined and the quartz is 4 to 24 inches wide, but the sulphide content is low and the grade is sub-commercial.

No. 2 vein became sub-commercial a considerable distance west of the fault and only 1102 and 1302 drifts were driven easterly through the fault. In the drifts on Veins 1 and 2 the vein narrows gradually to the east, and often only short disconnected lenses of quartz and calcite are found. The shear is not more than 4 inches wide.

Gash or Tension Veins.—Many short gash or tension veins branch from either wall of the main veins. These gash veins are from a few feet to about 30 feet long, dip steeply northward, range in strike from north 57 to 67 degrees east, and join the main veins at an angle rarely greater than 20 degrees. As they do not offset the main vein along their strike, they appear to be tension openings along which there has been little movement. The orientation of the gash veins with respect to the main vein indicates that the north wall of the main vein has moved westerly, and, as indicated by offsets on dykes and strata, the movement has been slight, up to only about 10 feet. The strike of most of the gash veins is close to the direction of tension in the strain ellipsoid set up for the mining camp as a whole (Figs. 2 and 3).

Faults on Nos. 1 and 2 Veins.—The veins are cut by intra-vein faults that parallel and lie within the vein shear both on strike and dip and are also cut by offsetting cross-faults.

The intra-vein faults offset beds and dykes that cross the shear. Along most of No. 1 vein the north side has been displaced westerly with respect to the south side. Along intermediate wedges of ground between breaks, slippage, due to the compound nature of the fracture zone, has occurred, and the offsetting of dykes, as seen in some sections of the drift, may have been reversed, so that for some small blocks the north side of a vein has moved easterly. In no offsetting is the horizontal displacement more than a few feet. Although some displacement may have occurred prior to the vein filling, some also occurred afterwards. The marked ribbon texture of the vein in places is the type that results from an abundance of early intra-vein faulting.

One pronounced cross-fault, known as the Main Fault, and several smaller ones cut the veins. The Main Fault, strike north 17 degrees east (Fig. 9) and dip 70 degrees northwestward (Figs. 10 and 11), offsets the eastern continuation of the main veins in the eastern part of the mine. Except where cut by a few stringers of calcite, probably leached from the wallrock, the strongly sheared and slickensided rock along the fault is quite unaltered and uncemented. The width of sheared rock ranges from 5 to 12 inches on the 600 level and to 8 feet on the 1200 level. The Main Fault slices the veins off abruptly and, dragging a small amount of vein matter with it, offsets the easterly continuation of the veins 28 feet northerly along the level. The vertical component of the displacement in the plane of the fault is not definitely known. Fluting on the hangingwall of the fault on the 600 level plunges 15 degrees northerly, and, if related to the main movement on the fault, suggests that the vertical component may be small, and also suggests that the fault is of the reverse or thrust type in which the hangingwall has moved up with respect to the footwall. It may be noted that the dip of the fault is 70 degrees, which is much steeper than is usual in reverse faults, of which the dips are seldom greater than 45 degrees. The amount of the horizontal displacement as seen underground has not been sufficient to offset the surface outcrops of the formations by an amount that is determinable in the widely separated outcrops.

A few small cross-faults, along which the displacement has been less than 10 feet, cut the veins.

A fault zone 20 feet wide, strike northerly and dip 62 degrees eastward, crosses the vein on the 900 level 150 feet from the portal. The hangingwall sediments along a prominent footwall slip are bent downward at the slip, which suggests that the hangingwall of the fault moved up with respect to the footwall, as in a thrust or reverse fault. However, the displacement appears to have been only a few feet.

No. 3 Vein.—This vein (Fig. 9), strike north 67 degrees east and dip steeply southward, branches northeasterly from No. 2 vein. Although a drift had been driven on the vein some years ago, at the time of the writer's last visit in September, 1946, it had been crosscut only on the 1000 and 1100 levels. However, more recently, it has been followed by drifts on the 1200 and 1300 levels and considerable stoping has been done. No. 3 vein has responded favourably to development, and prior to closing of the mine in 1948 it had become the principal source of ore at the mine. It is interesting to note that the strike of the vein is close to the general direction of tension for the camp (p. 45). The extent of the drift on the 1000 level is shown in Figure 9. By September, 1946, a drift had been driven 230 feet northeasterly from the intersection of Nos. 3 and 2 veins on the 1100 level. On the 1000 level a length of 120 feet had been stoped to a height of 60 feet above the southwestern drift.

In the southwestern drift on the 1000 level, the vein, 2 to 4 inches wide, follows a well-defined shear in a sheeted zone that is 2 to 4 feet wide and consists of several parallel joints in the enclosing quartz diorite. The northeastern portion of the drift is in sediments where the sheeted zone disappears, and only a single shear with a small amount of vein matter is present. In structural, textural, and mineralogical features No. 3 vein is similar to Nos. 1 and 2 veins.

No. 4 Vein.—This vein (Fig. 9), 45 feet north of No. 3, was explored on the 1000 level by a few feet of drifting on either side of the crosscut. The vein matter is poorly defined and consists of several short stringers of quartz, strike easterly to northeasterly and dip almost vertical. The quartz in the stringers is less than an inch thick, and single stringers extend for only a few feet before dying out.

No. 5 Vein.—This vein, strike east and dip about vertical, was cut in the crosscut on the 1000 level at a point 720 feet north of No. 1 vein and 230 feet north of No. 2 vein (Fig. 9). A drift 55 feet long has been driven on this vein, but no stoping has been done. The vein consists of a narrow stringer of quartz and coarsely crystalline carbonate, but no sulphide, in a shear zone that ranges in width from 3 inches in the east face to 1 foot in the west face. Considerable coarse carbonate is found in the shear. On Nos. 1 and 2 veins, abundant coarse carbonate is found on the 1200 and 1300 levels, and abundant sulphides are found above these levels. This fact suggests the possibility that the coarse carbonate in No. 5 vein on the 1000 level may be succeeded higher in the vein by abundant sulphides.

Other Veins.—Although Nos. 1, 2, 3, 4, and 5 veins comprise the principal veins opened up in the main part of the Privateer mine, other veins have been found but not extensively developed. These include veins on the 600 crosscut from the Privateer to the Prident and on the 1100 level of the Privateer, and will now be described.

The 600 crosscut intersects several quartz veins. Short drifts were driven on some of them, and on one, the " H " vein, a small amount of stoping was done. Eight of these veins in Privateer ground have been named alphabetically, from "A" to " I," from northwest to southeast.

"A" vein is 190 feet southeast of the point where the long crosscut bends away sharply southeastward from the drift on No. 1 vein. Drifts have been driven 15 feet northeasterly and southwesterly on the vein. It consists of a lens of quartz and pyrite up to 10 inches wide that follows a shear zone 2 feet wide, strike north 27 degrees east and dip vertical. Post-mineral movement along the shear has crushed some of the quartz and pyrite. Vein matter is widest in the northeastern face but is lacking in the southwestern face.

" B " vein, strike north 48 degrees east and dip about vertical, is 175 feet southeasterly from "A" vein. It is a quartz-carbonate vein one-quarter of an inch to 1½ inches wide with only a small amount of sulphide and is accompanied by a thin film of sheared rock on each wall, no wide shear zone being present.

" C " vein, strike north 23 degrees east and dip 73 degrees southeastward, is 138 to 140 feet southeasterly from " B " vein and follows a well-defined shear zone 3 inches wide along the contact of altered sediments and quartz diorite. The vein-filling contains a little quartz with abundant pyrite in places.

" D " vein, strike north 56 degrees east and dip nearly vertical, is 65 feet southeast of " C " vein. The vein quartz, which is up to 8 inches thick in places, is lenticular and follows a well-defined shear zone 2 feet wide. The vein is similar to "A" vein in amount of shearing but contains less vein matter. Drifts have been driven on the vein for 10 feet northeasterly and southwesterly from the crosscut.

" E " vein, strike north 47 degrees east and dip 75 to 78 degrees southeastward, is 60 feet southeast of " D " vein. It consists of a quartz-sulphide stringer one-quarter to half an inch wide that follows a weaving course in a well-defined shear zone 3 inches wide. The shear contains both gouge and sheared rock. A round has been blasted from the vein on both sides of the crosscut.

" F " vein, strike north 60 degrees east and dip 72 degrees northwestward, is 110 feet southeast of the " E " vein. It is a quartz-calcite vein a few inches wide and is accompanied by gouge up to 2 inches wide on the footwall. Coarsely crystalline calcite is abundant, but sulphides are not.

" G " vein, strike north 37 degrees east and dip steeply southeastward, is 205 feet southeast of the " F " vein. Drifts have been driven 90 feet northeasterly and 135 feet southwesterly on this vein, but no stoping has been done. It is a well-defined quartz vein 1 to 2 inches thick and is accompanied by a paper-thin gouge on the walls but by no extensive shearing. The quartz contains moderately abundant pyrite and a small amount of sphalerite.

" H " vein, strike north 30 degrees east and dip 78 degrees southeastward, is 50 feet southeast of " G " vein. Drifts have been driven 55 feet northeasterly and 130 feet southwesterly on this vein, and it has been stoped for a few rounds above the southwest drift for 40 feet. The vein is a lenticular ribbon of quartz half an inch to 2 inches thick that follows one of a series of joints in a sheeted zone in the quartz diorite. Unlike the other veins in the 600 crosscut, this vein and the " I " vein (to be described) contain a moderate amount of fine-grained arsenopyrite.

" I " vein, strike north 27 degrees east and dip vertical, is 50 feet southeast of " H " vein. Drifts have been driven on the vein for 15 feet on either side of the crosscut. The vein, 1 to 2½ inches wide, consists of quartz, pyrite, and a little fine-grained arsenopyrite and is accompanied by a little gouge but no sheared rock.

For 30 feet southeasterly from the "I" vein the crosscut intersects many narrow, northeasterly striking, steeply dipping, quartz stringers. They contain only small amounts of sulphide.

The crosscut passes from Privateer into Prident ground 130 feet southeasterly from the "I" vein and ends in the face at 255 feet southeast of the "I" vein. Although the next two veins, the "K" and "L," along the crosscut belong to the Prident company, a wholly owned Privateer subsidiary, they will be described here to maintain the geological continuity of description.

The "K" vein consists of short individual stringers of quartz up to 2 inches thick, strike north 40 degrees east and dip steeply southeastward, and 150 feet southeasterly from the "I" vein it has been followed by an irregular drift, referred to as the "K" drift (Fig. 13), for 180 feet northeasterly. The most continuous vein matter is in the central part of the drift and has a length of 90 feet. The vein matter is quartz with patches of pyrite and, in one place, a 1-inch stringer of coarsely cleaved carbonate. It is possible that the vein matter in the "K" drift, particularly that in the central section, which strikes northeast, is the downward extension of the north 40 degrees east vein found in the 400, 500, and 600 levels of Prident. The 600 level of the Prident is 290 feet above 600 level of the Privateer.

The "L" vein, strike north 42 degrees east and dip vertical, has been followed for 180 feet northeasterly from the crosscut by a drift, referred to as the "L" drift (Fig. 13), 90 feet southeast of the "K" drift, strike north 42 degrees east and dip about vertical. This is a well-defined quartz vein, which is from 1½ to 4 inches wide, and which contains pyrite and a small amount of sphalerite. This vein is vertically below the vein in the 3-W drift on the Prident 400 level, but because the vein in Prident 400 dips 65 to 70 degrees southeastward, it is probably in a different fracture.

Beginning 60 feet along this "L" drift, a branch drift has been driven north 70 degrees east for 180 feet and at 110 feet along this branch drift a raise has been driven 290 feet to the 600 level on the Prident. This branch drift follows a few stringers of quartz one-sixteenth of an inch to 1 inch thick that may be the downward extension of the north 72 degrees east vein on the 600 level of the Prident northeasterly and southwesterly from the top of the raise.

On the 1100 level, the entry crosscut intersects a narrow stringer of quartz, strike about north 5 degrees east and dip about vertical, at a point 105 feet from the portal. At 115 feet a drift extends 70 feet north-northeasterly, and between points 35 feet and 55 feet from the crosscut the drift intersects a zone 15 feet wide of closely spaced quartz stringers, strike north 50 degrees east and dip about vertical. In an attempt to intersect the southwestern continuation of this zone of stringers, four diamond-drill holes were drilled in a southeasterly direction from the bank of Spud Creek between 40 and 60 feet upstream from the adit. Quartz was cut in all the holes at about the expected positions and encouraging amounts of gold were found in some intersections. No other work has been done on this zone of quartz.

Veins outside the Main Privateer Workings.—Several veins have been found on the Privateer property beyond the main workings. Of these, the most important are the P.E., P.-4A, and P.-3D veins.

The P.E. vein (Fig. 8), strike north 40 to 48 degrees east and dip vertical, has been traced on the Pilgrim Extension claim (L. 1043) of Privateer Mine, Limited, by surface workings and on the White Star claim (L. 1031), part of the White Star property, by surface workings and by a short adit on the White Star claim (L. 1031) for a strike length of about 750 feet between elevations of 750 and 1,300 feet.

The vein ranges in width from 6 to 28 inches and follows a well-defined shear usually a few inches wider than the vein. The quartz is mineralized with pyrite and a small amount of galena and fine-grained arsenopyrite.

Several open-cuts have traced the vein up the hillside from the lowest cut, at an elevation of 750 feet, to the adit, elevation 1,300 feet. In the cuts that have caved, the vein is covered. In the lowest cut, 750 feet elevation, the quartz is 10 to 28 inches wide and contains a few patches of pyrite, but no galena or sphalerite. In a cut about 30 feet northeasterly from the last, the vein is 4 to 6 inches wide and is accompanied by 24 inches of intensely sheared rock. In an open-cut, elevation 1,155 feet, the vein shear, strike north 38 degrees west and dip vertical, is 6 to 8 inches wide and contains a lens of quartz that is 2 to 8 inches wide and extends 4 feet down the dip.

In the White Star adit, elevation 1,300 feet, which has been driven north 40 degrees east for 32 feet on the P.E. vein, the vein is 6 inches to 2 feet wide and follows a well-defined shear a few inches wider than the vein matter.

The P.-4A vein is on the Riverside (L. 1781) and Privateer No. 4 (L. 1696) claims, at an elevation of 645 feet, on the northeast bank of a small creek flowing into the Zeballos River at the Ford bridge. A drift 158 feet long (Fig. 12) has been driven on the vein. A light high-line service tram, approximately 800 feet long, was strung several years ago from bunkers near the portal of the adit to a point on the main road opposite the Ford bridge.

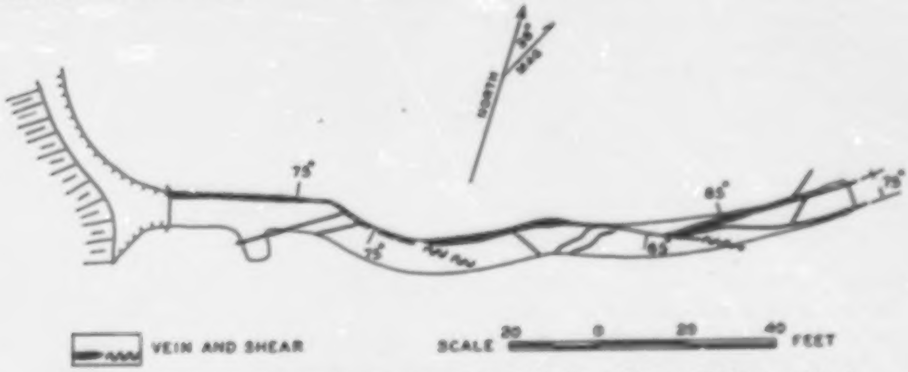

Fig. 12. Privateer: Adit on P.-4A vein on Riverside (L. 1781) and Privateer No. 4 (L. 1696) claims. Tape and compass survey.

The vein, with a general strike of about north 70 degrees east, follows a zigzag course (Fig. 12) along a fracture zone about 10 feet wide. From the portal to 35 feet the vein, 4 to 6 inches wide, strikes north 75 degrees east and dips 75 degrees northward, and from 35 to 58 feet the adit follows a diagonal shear 1 inch wide, strike north 87 degrees west and dip 75 degrees southward. Widely spaced lenses of quartz 2 inches wide occur along the shear. At 58 feet the diagonal shear continues easterly into the wall of the drift, but to 94 feet the vein follows another shear with a strike of north 65 degrees east and widens to 8 inches in places. From 94 feet it follows a diagonal shear, strike north 82 degrees east and dip 65 degrees southward, and narrows to 3 inches. At 120 feet the vein matter leaves the diagonal fracture to follow to the face a shear, strike north 57 degrees and dip vertical, and maintains a width of 3 inches until near the face where it narrows to 1 inch. The strike of the better portions of the vein, and therefore probably the main direction of shearing, is north 57 to 75 degrees east. As may be seen from Figure 12, several narrow stringers, usually about an inch wide, some of which strike northeasterly and some northwesterly, join the wider sections of the vein.

The vein matter is friable quartz, some of it vuggy, with pyrite and sphalerite between the quartz crystals. Masses of pyrite, pyrrhotite, and intensely crushed chalcopyrite are found along the wider sections of the vein. A few patches of coarsely cleaved calcite were seen along the vein. Several different types of sulphide mineralization were selected for assay, and the results are given in the following table:—

	Gold.	Silver.	Copper.	Lead.	Zinc.
	Oz. per Ton.	Oz. per Ton.	Per Cent.	Per Cent.	Per Cent.
Massive pyrrhotite	0.27	0.3	0.11	0.22	2.17
Massive pyrite	0.58	0.7	0.10	0.91	1.10
Quartz and sphalerite	0.02	0.6	0.15	0.12	3.99
Pyrite with considerable galena and sphalerite in crustiform quartz	1.82	5.2	0.14	5.36	2.77

The P.-3b vein, strike north 25 degrees east and dip 64 degrees northwestward, is on the Progress No. 3 claim (L. 1063), where it has been prospected by a drift 25 feet long at an elevation of 1,100 feet. The vein, 4 inches wide, consists of massive quartz containing small patches of chalcopyrite.* It lacks the pyrite-galena-sphalerite mineralization typical of most of the veins in the productive area. The wallrock is mainly quartz diorite, cut in places by small dykes of light-coloured granodiorite.

Structural Control of Ore Deposition.—The principal veins at Privateer appear to have been localized along the axial plane of a trough at a sharp bend in the contact of the main mass of quartz diorite. This feature is exemplified in Figure 2, where it may be seen that the veins are at a sharp bend in the otherwise straight contact of the quartz diorite. At this bend, the sediments and volcanics have been deformed into a fold in the form of a trough plunging steeply southwestward. The veins strike approximately parallel to, and are very close to, the axial plane of this trough or fold; it is probable that they formed here, rather than elsewhere along the contact of the quartz diorite, because of local tension along the axial portion of the fold.

Localization of ore within the veins appears to be related in part to the heterogeneity of rock types and complexity of folding at the mine and in part to the degree to which the veins or parts of them follow the favourable direction of tension established for the producing area of the camp as discussed on pages 43 to 45.

In the stoped sections the veins cut through a heterogeneous assemblage of rock types that includes lenticular bodies and dykes of quartz diorite and lime-silicate and interbedded volcanic rocks. Beyond the stoped areas, the veins enter relatively homogeneous, massive volcanic tuff on the west and relatively homogeneous, massive lime-silicate rock towards the east. This suggests a correlation between ore and heterogeneity of rock types.

A relation between high-grade ore and dragfolding appears to hold for the western part of No. 1 vein. The dragfolds have vertical axial planes that strike north 15 degrees west to north 10 degrees east and the crest lines are horizontal. They are developed best where the west ends of the levels between 800 and 1100 intersect the surface (Fig. 10). The most continuous and highest grade oreshoots were mined from this section of No. 1 vein.

A correlation exists between the deposition of ore and the strike of the veins; this is illustrated by the fact that the relatively high-grade No. 3 vein and the high-grade western part of No. 1 vein follow closely the direction of tension in the fracture pattern (p. 45).

Prident.*

Prident Gold Mines, Limited, 521 Metropolitan Building, Vancouver, owns controlling interest in the Golden Peak No. 4 Crown-granted claim (L. 1032), staked in 1934 by Joe Doyle. From 1937 to 1938 the property was developed by Western Holdings, Limited, of Vancouver, who did surface work and drove the 500 level 140 feet. In July, 1938, Dentonia Mines, Limited, acquired the property, started and drove about 100 feet of drift on an easterly striking vein at elevation 2,010 feet close to the northeastern boundary of the property and appears to have driven the 200 level on the western continuation of the same vein. This company also started work on the 400 level. Early in 1939 the property was acquired by Prident Gold Mines, Limited, in which Privateer Mine, Limited, held controlling interest and Dentonia the remainder; later, Privateer acquired full interest in Prident and has done all subsequent work on the property.

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* See Figure 13 in pocket and Figures 14, 15, and 16 in text.

Prior to 1939 high-grade ore from Prident was shipped to Tacoma, but since then it has been put through the Privateer mill. In 1942 the long crosscut from the Privateer on the 600 level was completed, and a raise 290 feet long was driven to the 600 level of the Prident. Since then all Prident ore has been passed through the raise, trammed along the Privateer 600 crosscut, and dropped through ore-chutes of the Privateer mine to the 1100 or mill level. Shortly after acquiring the property, the Privateer company built an inclined surface tramway to connect the Prident with ore-bunkers on Spud Creek, but it is now used only as a service tramway.

The production data for Prident for 1941 and subsequent years are given in the following table:—

Production Data, Prident Operation of Privateer Mine, Limited.[*]

	Tons trammed to Mill.	Gold, Gross.	Silver, Gross.
		Oz.	Oz.
1941	3,822	3,805	2,104
1942	7,075	5,141	2,879
1943	7,055	3,758	2,098
1947†	2,106	687	349
1948†	1,923	546	281
Totals	21,981	13,937	7,711

[*] Data from annual reports to shareholders of Privateer Mine, Limited.

† Personal correspondence, Privateer Mine, Limited.

To September, 1946, seventeen diamond-drill holes, totalling 860 feet, had been drilled. They are distributed as follows: On the 400 level, one hole, 68 feet long; on the 500 level, six holes, totalling 269 feet; on the 600 level, five holes, totalling 180 feet; on the 750 level, two holes, totalling 71 feet; and on the 900 level, three holes, totalling 272 feet.

The property is within the main area of quartz diorite, which is the principal rock type on the property. However, there is a large inclusion of granitized volcanic rock in the most eastern drift on the 400 level at the 407 stope (Fig. 15), and feldspar porphyry dykes cut the quartz diorite at several places in the workings.

The rock in the inclusion is similar mineralogically to the enclosing quartz diorite but differs in having a darker colour, a finer grain-size, and a general blotchy appearance caused by small clusters of hornblende. The contact between the two rocks is gradational over a couple of inches and is irregular in detail, but, in general, trends northerly to northeasterly and dips steeply eastward (Fig. 15). Along the drift below 407 stope and the sublevel above the 400 level, the continuity of the inclusion is interrupted by two intervening lenses of quartz diorite. Outcrops are few on the surface close to 407 stope, and it was not possible to identify the inclusion, but Bancroft (1940, p. 14) notes that volcanic remnants of the Bonanza formation outcrop on the Blackbird claim (L. 1055) directly northeast of the Golden Peak No. 4 claim (L. 1032). It is possible that the granitized volcanic inclusions in 407 stope belong to the volcanic remnants referred to by Bancroft.

Feldspar porphyry dykes, with dark groundmass and conspicuous light-coloured feldspar phenocrysts, cut the quartz diorite on all the levels. These dykes range in width from a few inches to 8 feet, strike from northwesterly to northeasterly, and dip, at 60 degrees or more, steeply in both an eastward and westward direction.

Veins.—Three major veins that strike north 40 degrees east, north 80 degrees west, and north 72 degrees east, and three minor veins of intermediate strikes have been developed by several adits (Fig. 13). Two small veins, the "K" and "L" veins, are on Prident ground but have been explored from the 600 drift of the Privateer and have been described on page 69 of this report.

North 40 Degrees East Vein.—This vein has been followed by drifts on the 400, 500, and 600 levels and stoped on the 400 and 500 levels (Fig. 14).

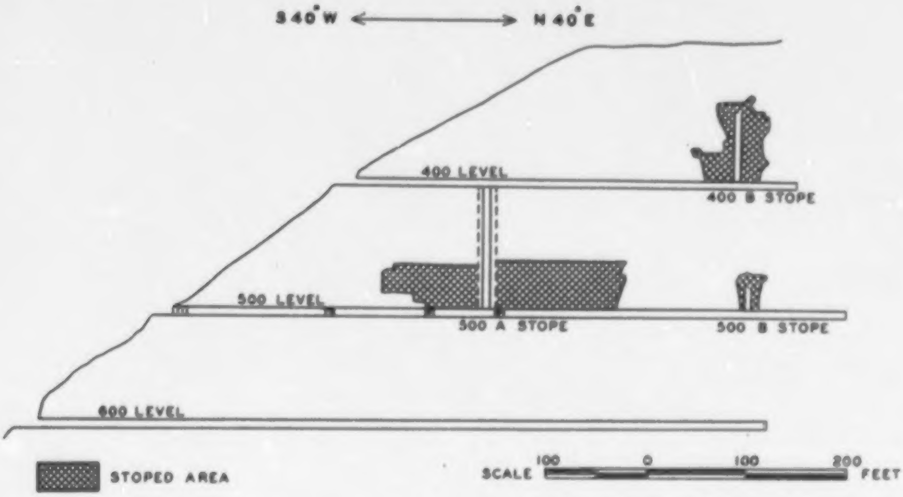

Fig. 14. Prident: Longitudinal section through 500-A and 500-B stopes on the north 40 degrees east vein.

The vein, half an inch to 5 inches wide, follows a series of parallel joints, strike north 40 to 42 degrees east and dip steeply southeastward, and passes from the one to a second parallel joint by way of diagonal shears, strike north 70 to 90 degrees east and dip 55 to 60 degrees northward. This structural feature will account for the fact that although the vein, a single quartz-filled joint, dips southeastward, the different levels on the north 40 degrees east vein are vertically above each other. The quartz in the vein is ribboned with layers of fine-grained pyrite and arsenopyrite. In the diagonal portions of the vein, the quartz is white, lensy, vuggy, and crystalline. In the northeastern face the vein disappears as the joint weakens to a paper-thin slip.

The 500 level follows a quartz stringer 1 inch wide for 390 feet from the portal. As this was apparently not the north 40 degrees east vein, as found in the 400 level above, a crosscut was driven 20 feet northwesterly from a point 260 feet from the portal that encountered a stronger vein of well-ribboned quartz from 2 to 8 inches wide with abundant pyrite. This vein appeared to be the downward extension of the vein in the 400 level and was followed northeasterly by a drift for about 420 feet.

On the 600 level, what appears to be the downward continuation of the main north 40 degrees east vein is tighter and narrower than in the upper two levels. However, it is a fairly continuous quartz-sulphide ribbon, which ranges in width from one-quarter of an inch to 3 inches. Heavy pyrite, sphalerite, and a little galena are seen in places in the roof of the drift. The vein in the northeastern face consists of 1 inch of quartz and calcite in a tight fracture. Where first seen in the 600 adit, at a point 220 feet from the portal, the vein, local strike north 32 degrees east and dip 80 degrees southeastward, is only one-quarter of an inch wide and follows a crush zone 5 inches wide. Within 100 feet the quartz widens to 2 inches.

The downward extension of the north 40 degrees east vein on the 900 level 290 feet below is probably the weaker vein found in the northeastern section of the "K" drift (Fig. 13).

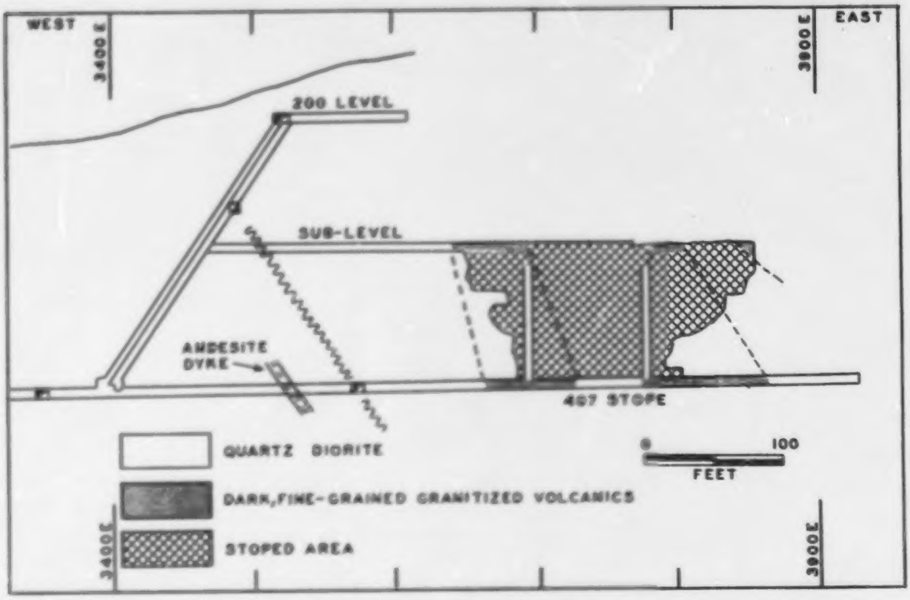

Fig. 15. Prident: Longitudinal section through 407 stope on north 80 degrees west vein, showing geology and stoped area.

North 80 Degrees West Vein.—This vein, which ranges in strike from north 75 to 80 degrees west and dips about vertical, has been followed by drifts on the 200 and 400 levels and by an intermediate sublevel (Figs. 13 and 15). It has been stoped between the 400 level and the sublevels (Fig. 15). It is understood that during 1947 and 1948 this vein was intersected on two of the lower levels, on the 500 level where it was followed for 100 feet, and on the 600 level where it was followed for 360 feet; during this time a raise was driven on the vein between the two levels. The writer has not had an opportunity to see this work. On the 200 level the vein was crosscut 70 feet from the portal and was then followed for 97 feet easterly. On the 400 level a crosscut driven easterly from a point on the north 40 degrees east vein 350 feet from the portal intersected the north 80 degrees west vein at 405 feet; a drift follows the vein easterly 590 feet to the face (Fig. 15). The first part of the crosscut follows some narrow stringers.

The vein, as seen on the several levels, ranges in width from a knife-edge to 12 inches and where stoped is usually 4 to 5 inches wide. Most of the vein matter is quartz with patches of abundant sulphide, but in places it contains angular inclusions of wallrock, some of which are replaced by quartz. It follows a well-defined shear zone 1 to 3 feet wide. The intensity of the shearing in this zone induces sloughing of the backs at many places, and considerable timbering is required. Although the ground is badly sheared in the vein shear, the displacement along it has amounted only to about 8 feet, the north side having been displaced westerly. Only one cross-fault has been noticed. At a point on the 400 level, 125 feet west of the 407 raise, a fault zone 15 feet wide, strike north 20 degrees east and dip 58 degrees southeastward, offsets the eastern continuation of the vein about 15 feet southerly.

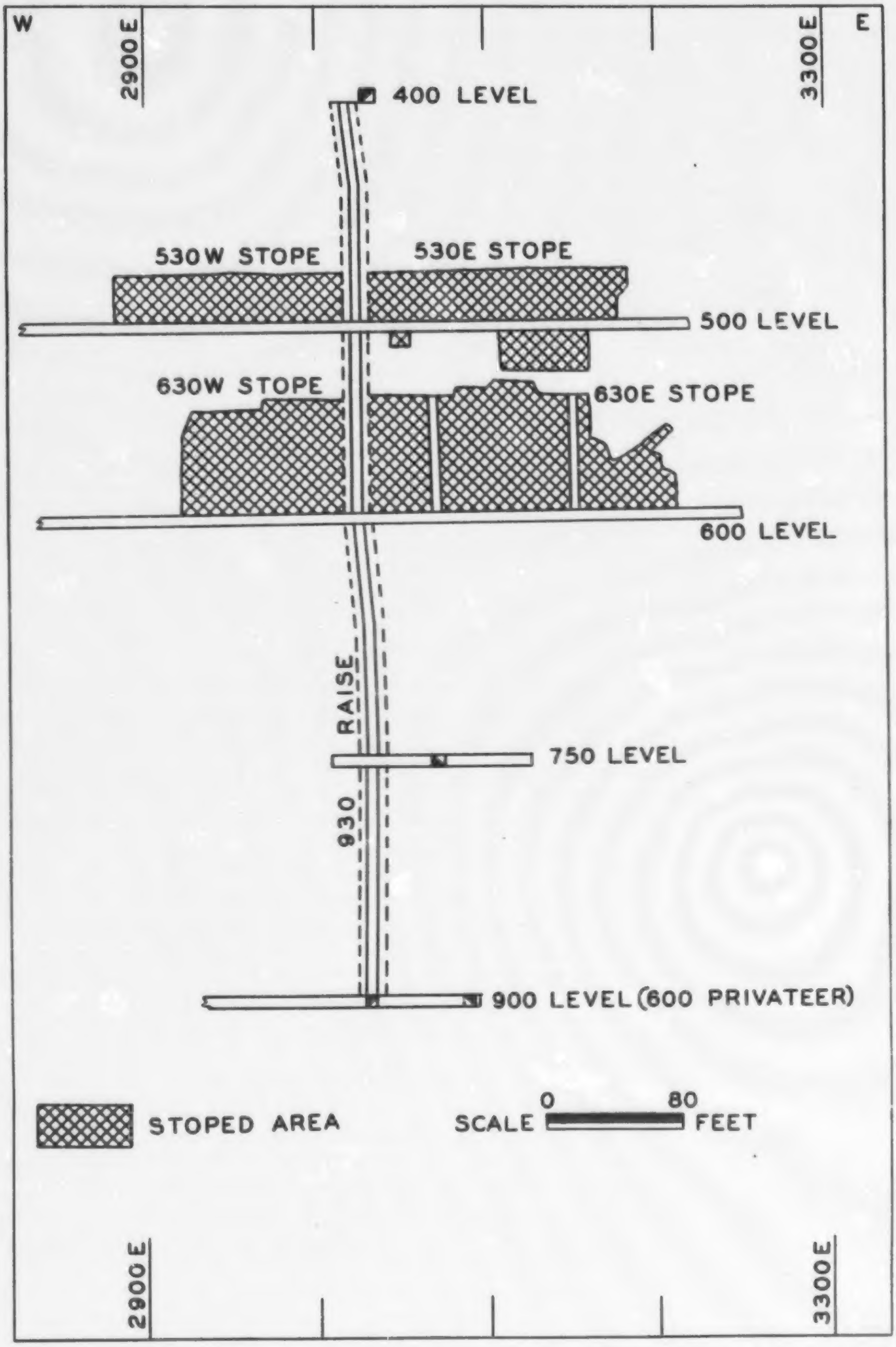
W
2900 E
3300 E
E
400 LEVEL
530W STOPE
530E STOPE
500 LEVEL
630W STOPE
630E STOPE
600 LEVEL
930 RAISE
750 LEVEL
900 LEVEL (600 PRIVATEER)
STOPED AREA
SCALE
0
80
FEET
2900 E
3300 E

Fig. 16. Prident: Longitudinal section through raise and the 530 and 630 stopes on the north 72 degrees east vein.

Branch or gash veins are not numerous and are found mainly east of 407 raise. Between points 90 and 130 feet east of the raise, a group of closely spaced, diagonal stringers of quartz, strike north 55 degrees east and dip 60 degrees northwestward and one-half to three-quarters of an inch wide, join the main vein on the south side, and about 40 feet west of the fault a group of stringers of similar strike join the vein on the north side.

At 407 stope (Fig. 15), for a length of about 200 feet, the vein shear cuts an inclusion of granitized volcanics, and in this part, although the vein shear is about 2 feet wide, its usual width, the quartz, here 1 to 2 feet wide, is wider than usual. The shear does not change its strike in passing from one rock to the other, but the composition of the granitized inclusion may have been sufficiently different to induce the greater precipitation of quartz there.

North 72 Degrees East Vein.—This vein has been followed by drifts on the 500, 600, 750, and 900 levels (Fig. 13) and has been stoped above the 500 and 600 levels (Fig. 16).

On the 500 and 600 levels the vein ranges in width from 2 to 6 inches and follows a well-defined shear 1 to 2 feet wide.

On the 750 and 900 levels the vein and accompanying shear are much narrower than in the upper levels, being only 0 to 1 inch wide in a vein shear, 2 inches wide on the 750 level, and consisting of a few lenses of quartz less than an inch wide on the 900 level. The amount of shearing accompanying this vein is much more than that accompanying the north 40 degrees east vein but is less than that accompanying the north 80 degrees west vein.

Three shorter veins have been followed by 3W, 3W-A, and 4W drifts on the 400 level and by the northern drift on the 750 level (*see* Fig. 13). The vein in 3W is a few inches wide and follows one of a set of joints which, 20 feet southwesterly from the main drift, becomes a shear 3 feet wide for several feet but towards the southwest face it narrows to 6 inches. The vein in 3W-A and in the northern drift on the 750 level is 1 to 5 inches wide and follows one of a set of parallel joints along which there has been considerable alteration of the wallrock. The vein in 4W, ranging in width from 1 to 5 inches, is similar to the one in 3W, in that it follows a clean-cut joint that passes into a crush zone 1 foot wide along its strike. All these veins are short and the vein matter in them narrows to merely a film of gouge towards the drift faces.

Fracture Pattern.—In the pattern of fractures at the Prident mine, the north 72 degrees east and north 80 degrees west veins appear to belong to one major direction of shearing and the north 40 degrees east vein to another. The displacement, as measured by offsets on dykes, is 5 to 10 feet along the north 72 degrees east and north 80 degrees west vein shears but is not more than 18 inches on the north 40 degrees east vein. As the displacement is in the same direction in both shears—namely, the north side of the shear displaced westerly—it is probable that the north 72 degrees east and north 80 degrees west vein shears, though differing by 28 degrees in strike, belong to the same general direction of shearing. The displacement along the vein in 3W-A on the 400 level has also been in the same direction, and it is probable that this vein shear also belongs to the general east-west direction of shear. The displacement along the north 40 degrees east vein shear has been in the opposite direction, the northwest side having moved northeast. It may be recalled that these are the general directions of the maximum shearing stress for the district as a whole (Fig. 3), and that the direction of displacement along the shears is also similar for the district as a whole.

The gash veins that branch from the veins in many places generally strike from north 50 to 70 degrees east, the most persistent of them striking about north 65 degrees east. The gash veins both from the easterly striking and from the north 40 degrees east vein shears strike in the same direction, thus indicating that they all belong to the same general direction of tension, which is also the general direction for the district as a whole (Fig. 3 and p. 45).

White Star. This property, on Spud Creek, consists of three Crown-granted claims: White Star (L. 1031), staked in 1933, and Don Fraction (L. 1033), staked in 1937 by A. Donaldson, and the Star Fraction (L. 1833), staked in 1937 by P. M. Monckton. The claims were brought to Crown grant in 1937 and 1939 and are now owned by Mr. Donaldson, 1333 Edmonds Street, New Westminster.

Between September, 1934, and June, 1935, the owners mined 15 tons of high-grade ore from open-cuts at about the level of the present No. 1 adit and 2½ tons of ore from an open-cut at about the same elevation on No. 2 vein. This ore was mined by hand, back-packed to tidewater, and shipped to the Tacoma smelter.

By 1938, 47 tons of ore, mostly from the original open-cut on No. 1 vein and averaging 14.5 ounces gold per ton, had been hand-mined and shipped by owners or lessees. By that time the transportation of ore had been improved by the building of a light jig-back tram-line from the camp, at the elevation of No. 1 adit, to Spud Creek, whence the ore was back-packed about half a mile to the end of the road at Privateer and thence hauled by truck to tidewater.

In 1939 the property was operated by White Star Mine, Ltd. This company installed machinery, extended Nos. 1 and 2 adits and started No. 3 adit, and by the latter part of the year had commenced shipping high-grade ore to Tacoma.

The mine was closed in 1942 and the mining plant dismantled. Since then no further work has been done.

Production data for the entire life of the mine are given in the following table:—

*Production Data, White Star Mine.**

	Ore mined.	Gold, Gross.	Silver, Gross.
	Tons.	Oz.	Oz.
Two months, 1935	2	32	9
To November 3rd, 1936	12	150	46
1937	21	359	104
1938	13	42	14
1939	358	2,122	710
1940	508	2,345	987
1941	400	1,531	830
To March 31st, 1942	100	500	255
Totals	1,414	7,081	2,956

* Data from British Columbia Bureau of Economics and Statistics and British Columbia Department of Mines.

The showings are entirely within quartz diorite, although the ground covered by the claims extends outside the contact. Several feldspar porphyry dykes from 1 to 10 feet wide are found on the property; some strike northerly, but the wider dykes strike north-northeasterly, and all are vertical or have steep dips.

Five quartz veins, Nos. 1 to 5 (Fig. 17), have been found, but Nos. 1 and 2 have produced all the ore mined. The veins contain moderate amounts of pyrite, galena, sphalerite, arsenopyrite, and free gold. In the wider sections the veins are drusy and the quartz so well developed in crystals perpendicular to the vein walls that a comb texture results. The sulphides are usually concentrated in bands towards the walls of the vein.

No. 1 vein, formerly known as the Donaldson vein, has been developed by No. 1 adit and the southeastern drifts on Nos. 2 and 3 adits, and part of the vein has been stoped from No. 2 level to the surface (*see* longitudinal section, Fig. 17). These workings extend for a total length of 460 feet along the strike of the vein and for a distance of 340 feet down the dip. The vein, strike north 35 to 40 degrees east and dip 70 to 80 degrees southeastward, follows a well-defined shear, 1 to 6 inches wide, in which the vein matter ranges in width from a knife-edge to 6 inches and, where stoped, is

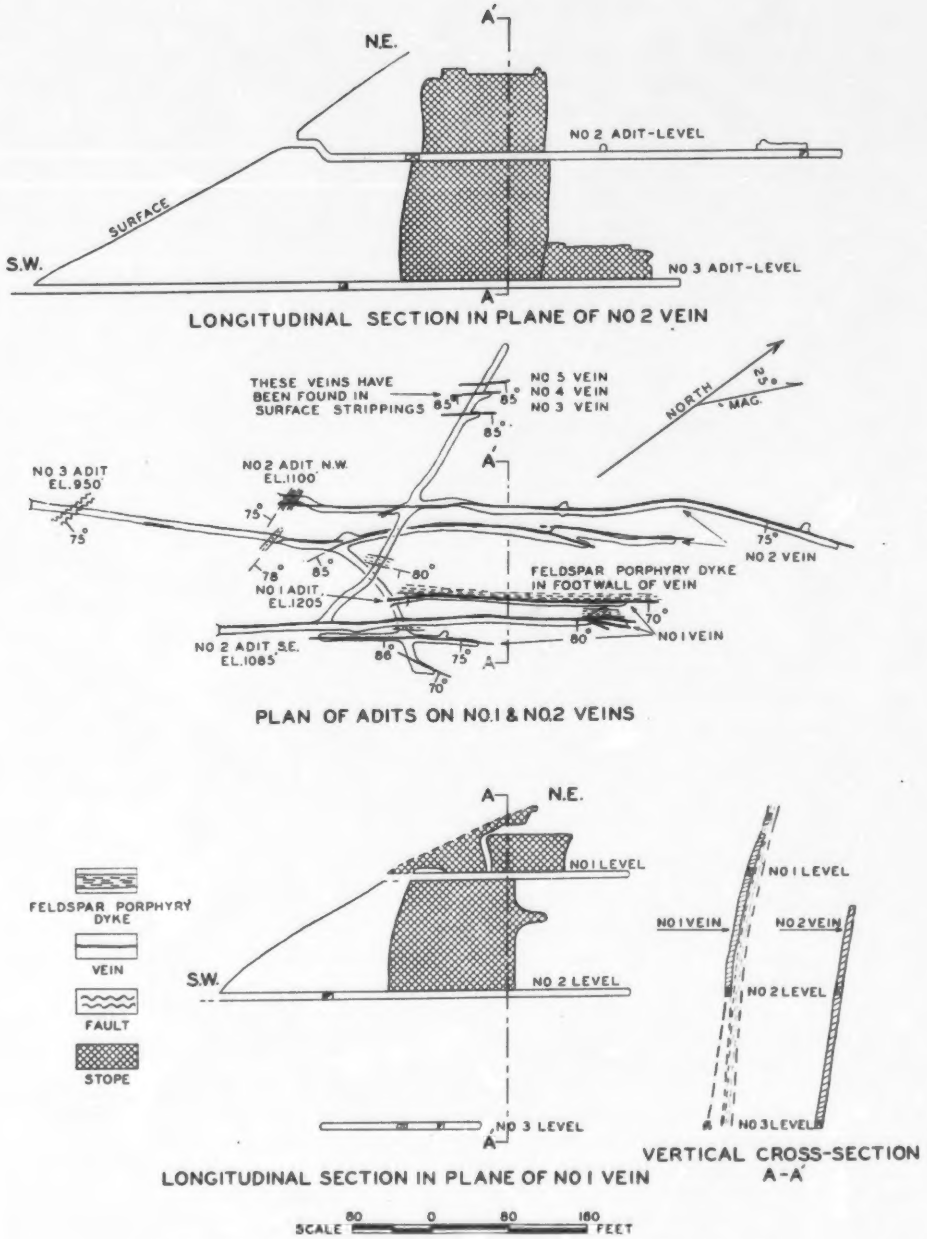
A'
N.E.
NO 2 ADIT-LEVEL
SURFACE
S.W.
NO 3 ADIT-LEVEL
A
LONGITUDINAL SECTION IN PLANE OF NO 2 VEIN
THESE VEINS HAVE BEEN FOUND IN SURFACE STRIPPINGS
NO 5 VEIN
NO 4 VEIN
NO 3 VEIN
NORTH
MAG.
25°
NO 3 ADIT EL.950'
NO 2 ADIT N.W. EL.1100'
NO 1 ADIT EL.1205'
NO 2 ADIT S.E. EL.1085'
FELDSPAR PORPHYRY DYKE IN FOOTWALL OF VEIN
NO 2 VEIN
NO I VEIN
75°
78°
85°
80°
86°
70°
PLAN OF ADITS ON NO.1 & NO.2 VEINS
FELDSPAR PORPHYRY DYKE
VEIN
FAULT
STOPE
NO I LEVEL
NO 2 LEVEL
NO 3 LEVEL
LONGITUDINAL SECTION IN PLANE OF NO I VEIN
NO I VEIN
NO 2 VEIN
NO 3 LEVEL
VERTICAL CROSS-SECTION A-A'
SCALE 80 0 80 160 FEET

Fig. 17. White Star: Plan and sections of underground workings.

usually about 4 inches wide. In Nos. 1 and 2 adits, the vein, following a course of north 40 degrees east, comes to a feldspar porphyry dyke, 6 feet wide, strike north 35 degrees east and dip 70 to 80 degrees southeastward, and follows the dyke; the southeast drift in No. 3 adit is not far enough northeasterly to reach the intersection of the dyke and the vein.

No. 2 vein has been developed by the northwestern drifts on Nos. 2 and 3 adits, and part of it has been stoped from No. 3 level to near the surface (*see* longitudinal section, Fig. 17). This vein, dipping steeply southeastward, varies in strike more than No. 1 vein. It follows a well-defined shear, about 6 inches wide, in which the vein matter has the same range of width as in No. 1 vein, but averages narrower, being usually about 2 inches wide.

Nos. 3, 4, and 5 veins are exposed in the northwestern crosscut in No. 2 adit. On visits to the property in 1935 and 1938 the writer noted these veins on the surface in three trenches, since caved, above the adit. These veins are, in general, parallel to Nos. 1 and 2 veins in strike and dip but are narrower and follow narrower shears. The veins range in width from a knife-edge to 1½ inches, and the vein shears are of similar widths.

As with other north-northeastern vein shears in the camp, the vein shears on the White Star are accompanied by diagonal breaks, many of them filled with comb quartz. A zone of diagonal quartz veins, strike north 65 degrees east and dip vertical, was seen in the back of the stope on No. 2 vein above No. 2 adit for a length of 25 feet. The diagonal veins are 1 inch wide, strike northeasterly, and dip steeply. A zone of similar diagonal veins, strike north 68 degrees east and dip vertical, was seen in a stripping, now largely obscured, 60 feet westerly from the cabin. These northeasterly diagonal quartz veins indicate that the northwestern or hangingwall of the vein shear moved northeasterly and down with respect to the footwall, in accordance with the movement of other vein shears of similar strike in the camp.

Five feldspar porphyry dykes have been found underground (Fig. 17), and most of them outcrop. The hangingwall of one dyke has been followed by No. 1 adit where it is in the footwall of the vein, and again by the southeastern drifts in Nos. 2 and 3 adits (Fig. 17). A second dyke, 10 feet wide and parallel to the first, is found in No. 2 level in the crosscut between Nos. 1 and 2 veins. Two smaller parallel dykes, strike northerly and dip steeply westward, are found near the portal of the northeastern drift on No. 2 level. One, 10 feet beyond the portal, is 2 feet wide and the other, at the portal, is 3 feet wide. A fifth dyke, strike northerly and dip steeply eastward, was found in the northeastern drift on No. 3 level 250 feet from the portal and may be the downward continuation of the third and fourth dykes mentioned above. The dyke at the portal of No. 2 adit northwest is cut and slightly displaced by the vein shear, and it is probable that the other dykes are also cut by the vein shears.

The principal fault movements at the White Star have occurred within the vein shears. The walls of all the veins are free and marked by films of gouge. Where the vein is absent from the shear, crushed rock and abundant fault gouge are present. Although the strike of No. 2 vein changes slightly, neither this vein nor No. 1 vein have been offset by transverse faults. However, a transverse fault zone, strike northerly and dip 75 degrees eastward, is found in the northeastern drift in No. 3 adit, 40 feet from the portal, where it consists of a zone of indefinite shearing 6 feet wide and a footwall streak of intense shearing 3 inches wide.

I.X.L.

This property consists of ground on the B-2 Fraction (L. 1054) that lies between the Golden Peak No. 4 (L. 1032) and the Golden Peak (L. 1035) (*see* Fig. 2). Britannia Mining and Smelting Co., Limited, owns the B-2 Fraction but is reported to have transferred the part between the Golden Peak claims to V. Davies, of Zeballos.

The workings consist of one adit and some strippings above it. There are no camp buildings. A blacksmith-shop and ore-shed, built near the portal of the adit, are reached by a foot-trail, about 1,000 feet long, running easterly from the White Star workings (Fig. 2). A haul-back aerial tram built in 1949 extends from the adit to the road.

The property is underlain by quartz diorite. The principal showing consists of a quartz vein half an inch to 4 inches wide, strike north 40 degrees east and dip 72 to 75 degrees southeastward, and follows a well-defined shear zone 1 to 36 inches wide. The quartz contains streaks of sulphides, which consist principally of pyrite and fine-grained arsenopyrite. A good deal of sloughing results from narrow shears, spaced about 6 inches apart, that parallel the footwall of the vein shear and slice the rock for as much as 3 feet into the footwall.

Prior to 1945 several strippings were made on the vein for a distance of about 1,000 feet northeasterly, and between 1945 and 1949 an adit was driven from the southwestern end of the line of stripping for 120 feet at north 40 degrees east. The owner reports that 24 tons of ore has been mined and that most of it was piled in the ore-shed.

The writer has visited the property several times, most recently in June, 1949. The assays in the following table are of samples taken in September, 1945, from the vein at points in the drift.

No.	Location and Description.	Gold.	Silver.	Lead.	Zinc.
		Oz. per Ton.	Oz. per Ton.	Per Cent.	Per Cent.
712E	At portal, black sulphide-gouge and white rock-gouge, each 1 inch thick. Sampled for 1 foot along strike	0.25	0.5	0.02	*Nil*
713E	Portal plus 5 feet: similar to 712E	0.06	1.9	0.04	*Nil*
714E	Portal plus 10 feet: black gouge and fine sulphides, 1 inch wide. Sampled for 1 foot along strike	0.70	2.2	0.04	*Nil*
715E	Portal plus 15 feet: across 2 inches of quartz containing ½ inch of fine-grained arsenopyrite	2.20	0.3	0.1	Trace
716E	Portal plus 20 feet: across 2 inches quartz and sulphide (pyrite and arsenopyrite)	12.01	3.5	0.7	1.2
717E	Portal plus 25 feet: 2 inches quartz plus a ⅜-inch streak of pyrite and arsenopyrite	17.31	4.6	0.1	Trace
718E	Portal plus 25 feet: across the ⅜-inch streak of pyrite and arsenopyrite of sample 717E	86.13	23.8	2.2	0.3
719E	Portal plus 30 feet: across 6 inches of quartz and a ⅜-inch streak of pyrite and arsenopyrite	4.78	23.8	*Nil*	*Nil*
720E	Portal plus 30 feet: sulphide streak only, of sample 719E	77.63	22.1	0.3	*Nil*
721E	Portal plus 20 feet: 3 feet of altered quartz diorite, containing disseminated pyrite cubes	0.40	*Nil*	*Nil*	*Nil*

Zeballos (Pacific) Gold Mines (Zeballos Gold Peak).

Zeballos (Pacific) Gold Mines, Limited, 716 Stock Exchange Building, Vancouver, owns the Gold Peak property, consisting of the following Crown-granted claims on Spud Creek: Golden Peak (L. 1035), Golden Peak No. 2 (L. 1036), Golden Peak No. 3 (L. 1037), Blue Star (L. 1034), Red Star (L. 1700), and Green Star (L. 1699), staked in 1933, and the Bloom Fraction (L. 1038), staked in 1937, all brought to Crown grant in 1938. Zeballos Gold Peak Mines, Limited, incorporated in 1937, with registered offices at 540 Columbia Street, New Westminster, built a camp, elevation 1,250 feet, about 900 feet east-southeasterly from the present camp, did preliminary surface exploration, and drove Nos. 3 and 4 adits (Fig. 18).

After a period of litigation, Zeballos (Pacific) Gold Mines, Limited, was formed in 1940 to acquire the property. This company continued work in No. 3 adit and drove Nos. 1, 0, and 00 adits (Fig. 18), built a new and larger camp about 200 feet north-northwesterly from the portal of No. 00 adit, and built a truck-road about 1,100 feet long southerly to the main Spud Valley road. The company ceased operations early in 1941 and dismantled the mining plant and camp; since then no further work has been done.

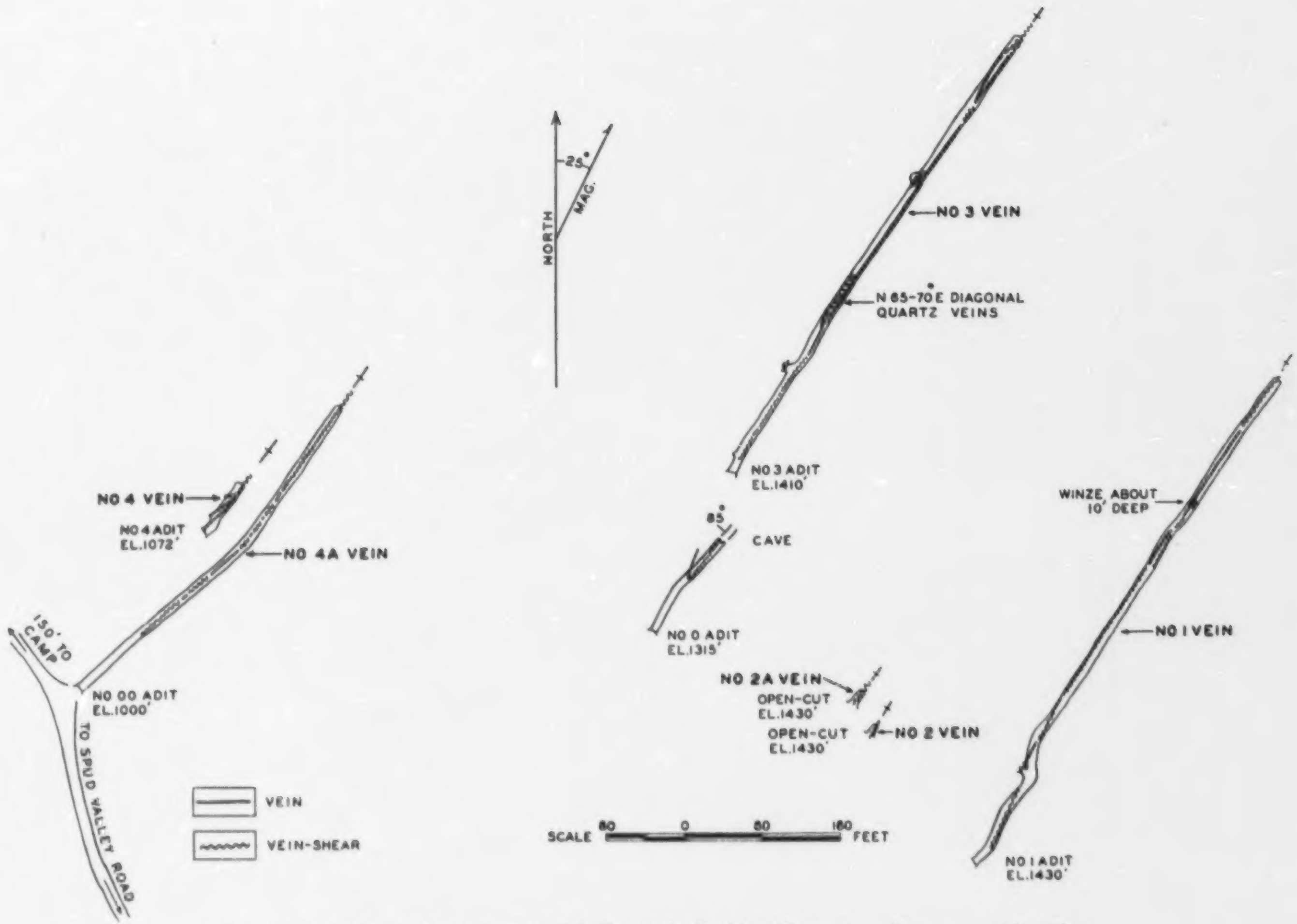
NORTH
MAG.
25°
NO 3 VEIN
N 65-70°E DIAGONAL QUARTZ VEINS
NO 3 ADIT EL.1410'
85°
CAVE
NO 0 ADIT EL.1315'
NO 2A VEIN
OPEN-CUT EL.1430'
OPEN-CUT EL.1430'
NO 2 VEIN
WINZE ABOUT 10' DEEP
NO 1 VEIN
NO 1 ADIT EL.1430'
NO 4 VEIN
NO 4 ADIT EL.1072'
NO 4A VEIN
150' TO CAMP
NO 00 ADIT EL.1000'
TO SPUD VALLEY ROAD
VEIN
VEIN-SHEAR
SCALE
80
0
80
160
FEET

Fig. 18. Zeballos Pacific (formerly Zeballos Gold Peak): Plan of workings on main veins.

Other than 400 tons of ore reported by Bancroft (1940, p. 16), there is no recorded production from this property.

Seven veins or vein shears, Nos. 1, 2, 2A, 3, 4, 4A, and Brown Bomber, have been variously developed by open-cuts and adits, but no raises have been driven, and no stoping has been done.

All the vein shears, excepting the Brown Bomber, are approximately parallel, strike north 35 degrees east, and are vertical. They are well defined and persistent, some of them being reported to extend northeasterly over the ridge towards Goldvalley Creek. They range in width from a few inches to 2½ feet and along their strike occasionally pass into sheeted zones up to 4 feet wide that consist of closely spaced, gouge-filled joints. These northeasterly striking shears contain less quartz and more gouge and crushed rock than is found in vein shears of other strikes and dips elsewhere in the camp and appear to represent the direction of maximum shearing stress in the producing area (Fig. 3).

The quartz vein matter in the shears has a maximum width of 8 inches but for long sections may be only a fraction of an inch wide. The quartz is mineralized with moderate amounts of sulphides, including pyrite, arsenopyrite, sphalerite, and galena, and when the sulphides are abundant, high assays in gold have been obtained. Clusters of pyrite cubes, unaccompanied by other sulphides or quartz, are found in the crushed rock and gouge of the shear zones, but no gold is associated with these pyrite cubes.

Samples of gouge and crushed rock, carefully taken to avoid contamination by crushed quartz-sulphide vein matter, contain very little gold.

No. 1 vein has been developed along its strike for 480 feet by No. 1 adit. It is exposed in an open-cut 100 feet higher than No. 1 adit and at a point 535 feet higher than the adit outcrops as a vein shear 3 feet wide containing 1 to 3 inches of quartz. Although a 1-inch gouge seam is found along the adit from the portal, the main vein shear is not seen until 100 feet from the portal. Here the vein shear is 2 feet wide and contains a quarter of an inch of quartz with half an inch of coarsely crystalline calcite. From this point the vein shear has been followed by drifting 480 feet northeasterly. The shear is generally from 1 to 2 feet wide, but in places it narrows, and the shearing is taken up along sheeted zones. Vein matter consists principally of quartz with minor amounts of sulphides, but calcite may occur with the quartz and may constitute most of the vein matter for lengths of a few feet. Locally, pyrite is abundant. Vein matter is not continuous along the drift. The vein matter has a maximum width of 2 inches, and in the 480 feet of drift the combined length of vein matter more than a quarter of an inch wide is only 190 feet.

Beginning 340 feet from the portal, for a length of 6 feet, the vein shear, strike north 35 degrees east and dip vertical, is intersected by several diagonal quartz veins 1 inch thick, strike north 65 to 70 degrees west and dip vertical. In another section, between 520 and 580 feet from the portal, the vein shear is also cut by several diagonal quartz veins of similar width and attitude. The strike of the diagonals in relation to the strike of the vein shear indicates that the northwest wall of the shear moved northeasterly.

No. 2 vein, 140 feet northwesterly from No. 1, has been exposed in an open-cut 10 feet long. In this vein three quartz stringers half an inch wide follow a sheeted zone 8 inches wide, strike north 30 degrees east and dip 85 degrees southeastward, that consists of gouge-filled joints spaced 1 inch apart. The mineralization is sparse.

No. 2A shear, 30 feet northwesterly from No. 2 vein, has been opened by a benched open-cut 20 feet long with an upper bench 8 feet above the lower. The shear, strike north 32 degrees east and dip approximately vertical, is 4 inches wide and well defined, but along the length exposed in the cut does not contain any vein matter.

No. 3 vein, 410 feet northwesterly from No. 1 vein, has been followed for 532 feet by No. 3 adit. In most places along the drift the vein shear consists of 1 to 8 inches of intensely crushed rock, but in some places the shearing follows closely spaced, parallel joints. The quartz vein follows the main shear, and where sheeting predominates, it follows one or two of the more prominent joints of the sheeted zones. The quartz ranges in width from a knife-edge to 8 inches, and the shear may be without quartz for as much as 40 feet along the strike. The individual sections of vein matter are from 2 to 100 feet long, and in the 532 feet in this adit vein-quartz sections ranging in width from a quarter of an inch to 8 inches have a combined length of about 400 feet.

Diagonal joints, strike north 70 degrees east and dip nearly vertical, are abundant. Many of these are filled with frozen quartz stringers a quarter of an inch to 1 inch thick in sections from 5 to 100 feet long, measured along the drift. Where they occur in sheeted zones, the diagonal quartz stringers extend between and connect the parallel quartz stringers of the sheeted zone.

At a point 140 feet from the portal, a short crosscut intersects a gouge seam 1 to 2 inches wide parallel to the main vein shear and a quartz lens 1 foot long accompanied by a 2-inch width of massive pyrite.

No. 0 adit, driven from a point 95 feet below No. 3 adit, was caved 120 feet from the portal when examined in August, 1944. A shear was encountered about 60 feet from the portal, from which point it extends, with a strike of north 35 degrees east and a dip of 85 degrees northwestward, beyond the caved ground. Where the shear is seen first, a branch, strike north 30 degrees east and dip vertical, extends to the northwestern wall of the drift. Near the wall, in a length of 2 feet, this branch contains half an inch to 2 inches of quartz. Near the cave, the main shear contains a 3-foot length of quartz and massive pyrite 2 inches thick. The vein shear in this adit dips 85 degrees northwestward and does not appear to be the downward continuation of No. 3 vein shear.

No. 4 vein is explored for a length of 62 feet by No. 4 adit, which was driven early in the history of the property. The shear followed by the adit strikes north 35 degrees east. Quartz vein matter consists of two stringers, 1 inch and 3 inches wide, that come into the northwest wall on a strike of north 55 degrees east. These stringers appear to represent diagonal veins. Well-defined vertical joints, strike north 58 degrees east, without quartz, are found near the portal. No quartz was seen in the shear near the face.

The lowest adit, No. 4A, follows a strong shear containing from 3 inches to 2 feet of gouge and crushed rock and lenses of quartz and sulphides half an inch to 1 inch wide up to 10 feet long. This vein shear is vertical and does not seem to be the downward continuation of No. 4 vein. From a point 260 feet from the portal, a branch shear, trending slightly more to the north and dipping 70 degrees southeastward, becomes the main shear.

The Brown Bomber vein is near the southeastern boundary of the Golden Peak No. 3 claim (L. 1037), where it has been exposed by four open-cuts for a strike-length of about 450 feet. The work on this vein was done when the property was first explored, and the writer did not have an opportunity to examine it. However, in describing this vein Bancroft (1940, p. 16) says:—

> The vein strikes north 57 degrees east and dips 80 degrees northward. It shows rusty vein material, gouge, and a 2-inch quartz stringer carrying finely divided pyrite and zincblende.

This vein is therefore noticeably different in strike from the other veins on the property and more nearly approaches the direction of tension for the district (p. 45).

Mount Zeballos.[*] This property comprises the following claims: A.X. (L. 1753), B.X. (L. 1754), J. (L. 1757), S.B. (L. 1756), 4X (L. 1755), B.G. (L. 1039), staked in 1936 and 1937 by H. E. Smith and P. M. Monckton; the Twinco (L. 1763), St. George (L. 1760), Flobald (L. 1759), Hans (L. 1758), Big Apple Fraction (L. 1762), staked in 1938 by S. H. Davis; and the Hank Fraction (L. 1764), staked in 1938 by H. Kinvig.

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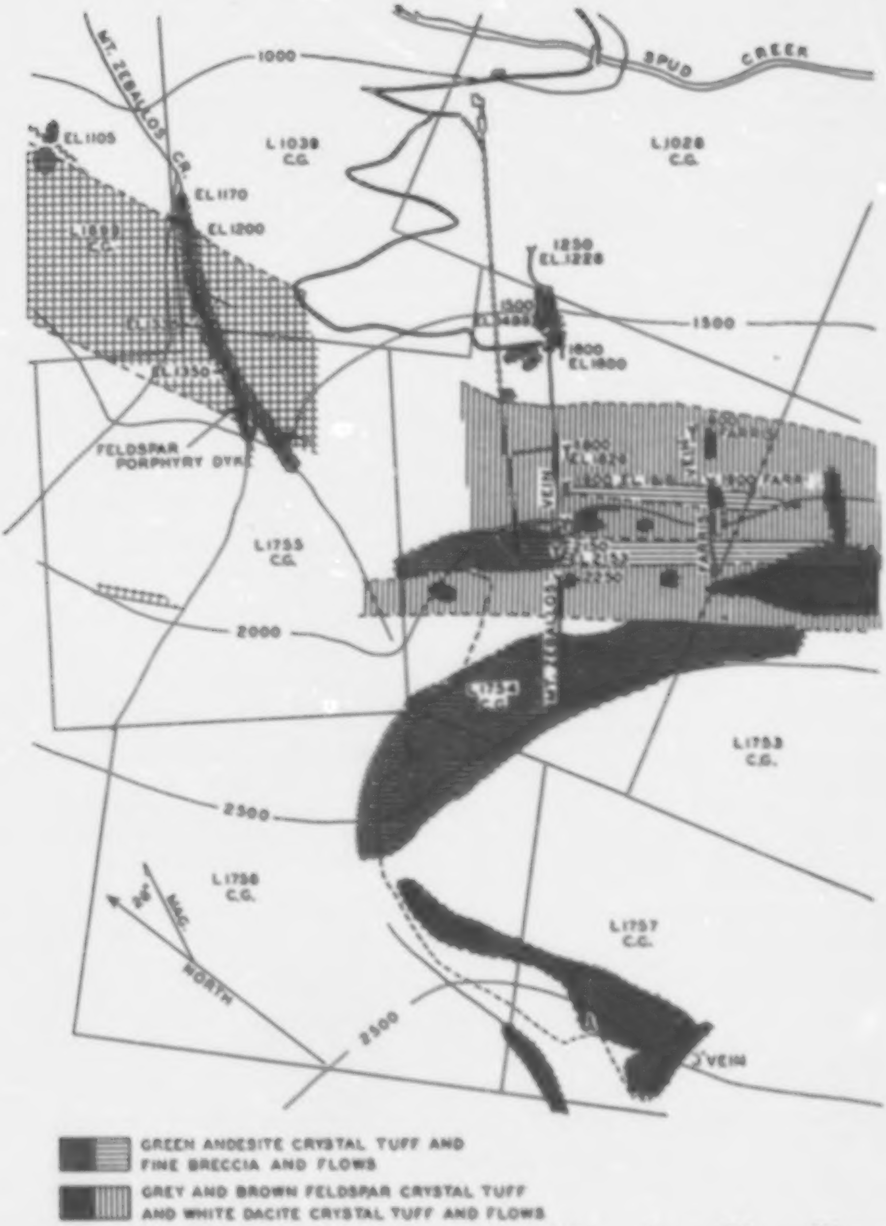
[*] *See* Figures 19 and 20 in text and Figure 21 in pocket.


MT. ZEBALLOS CR.
SPUD CREEK
1000
1500
2000
2500
2300
EL 1105
EL 1170
EL 1200
EL 1330
L 1038 C.G.
L 1028 C.G.
L 1555 C.C.
1230 EL 1226
1600 EL 1600
1800 EL 1826
FELDSPAR PORPHYRY DYKE
VEIN
FARRIS
MT. ZEBALLOS
2250
L 1755 C.G.
L 1753 C.G.
L 1756 C.G.
L 1757 C.G.
MAG. NORTH
VEIN
GREEN ANDESITE CRYSTAL TUFF AND FINE BRECCIA AND FLOWS
GREY AND BROWN FELDSPAR CRYSTAL TUFF AND WHITE DACITE CRYSTAL TUFF AND FLOWS
LIME-SILICATE ROCKS
SCALE 300 0 300 600 FEET

NOTE:

OUTCROPS ARE SHOWN BY DARK PATTERN; INFERRED EXTENSIONS ARE SHOWN BY A LIGHTER BUT THE SAME PATTERN.

Fig. 19. Mount Zeballos: Map showing surface geology.

Mount Zeballos Gold Mines, Limited, was incorporated in December, 1938, to acquire the above claims from Farris Zeballos Gold Mines, Limited. This company operated the mine until ore reserves were exhausted in 1942. In October of that year the company went into voluntary liquidation, and since then no work has been done on the property, except intermittent work by lessees from 1943 to 1945.

The Mount Zeballos vein was discovered in 1937, and in 1938 work was started on the 1600 and 1800 levels (Fig. 19). By the autumn of 1939 work had been started on the 1500, 1600, 1800, and 1900 levels and in 1940 on the 2000, 2150, and 1200 levels. In 1941 work was started on the 1700 and 2250 and also on the two levels on the Farris vein.

Twelve diamond-drill holes have been drilled northwesterly and southeasterly on the property, five from the 1250 adit, four from the 1600, and three from the 1800, in an attempt to intersect veins parallel to the main Mount Zeballos vein. The Farris vein was intersected in some of the holes drilled southeasterly, but no other veins of interest were found. The holes ranged in length from 76 to 584 feet, and the total footage drilled amounted to about 3,250 feet.

During the mining operations, ore was conveyed from the mine on an inclined surface tramway to the mill, which had a daily capacity of 65 tons, where it was treated by amalgamation and flotation. Except for 50 tons mined by lessees in the period 1943 to 1945, all ore from the start of mining operations in 1938 was treated in the company's mill. Twenty-five to thirty-five per cent. of the ore mined was sorted to waste before going through the mill. Concentrates produced amounted to 2½ per cent. of the tonnage milled.

Pertinent data on production and operation are given in the following table. Included in the table is a production of about 50 tons of ore, containing approximately 123 ounces of gold and 44 ounces of silver, mined by lessees from 1943 to 1945. About one-fifth of the gold and one-third of the silver were recovered in concentrates, the remainder in bullion.

Production and Operating Data, Mount Zeballos Gold Mines, Limited.[1]

	Ore mined.	Ore treated.	Gold, Gross.[2]	Silver, Gross.[2, 3]	Costs per Ton milled.[4]		
					Development and Exploration.	Mining.	Milling.
	Tons.	Tons.	Oz.	Oz.	$	$	$
1938	750[5]	....	....	....	......	......	......
1939	8,821[6]	6,337	3,277	976	7	7	7
1940	32,896[6]	23,529	14,716	5,528	2.85	5.02	1.58
1941	31,658[6]	21,261	9,744	6,571	2.430	6.484	2.099
1942	8,464[6]	5,686	2,665	1,382	2.02	4.22	3.01
1943	50[8]	....	123[8, 9]	44[9]	......	......	......
Weighted average[10]	....	....	....	....	2.58	5.54	1.96
Totals	82,639	56,813	30,525	14,501	......	......	......

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[1] Information, except where noted, from Yearly Summary Reviews of the Gold Mining Industry in Canada, published by Dominion Bureau of Statistics, Ottawa.

[2] Total metal content in crude ore, bullion, and concentrates as determined by settlement assay.

[3] Information from British Columbia Bureau of Economics and Statistics and British Columbia Department of Mines.

[4] Figures do not include taxes or head office, marketing, depreciation, and depletion charges.

[5] Development ore only, treated the following year in the mill.

[6] Mine-run ore, includes waste discarded on picking-belt.

[7] Information not available.

[8] Estimated, mined by lessees and shipped as crude ore to smelter.

[9] Contained in crude ore shipped to smelter.

[10] Weighted for variation in yearly tonnage.

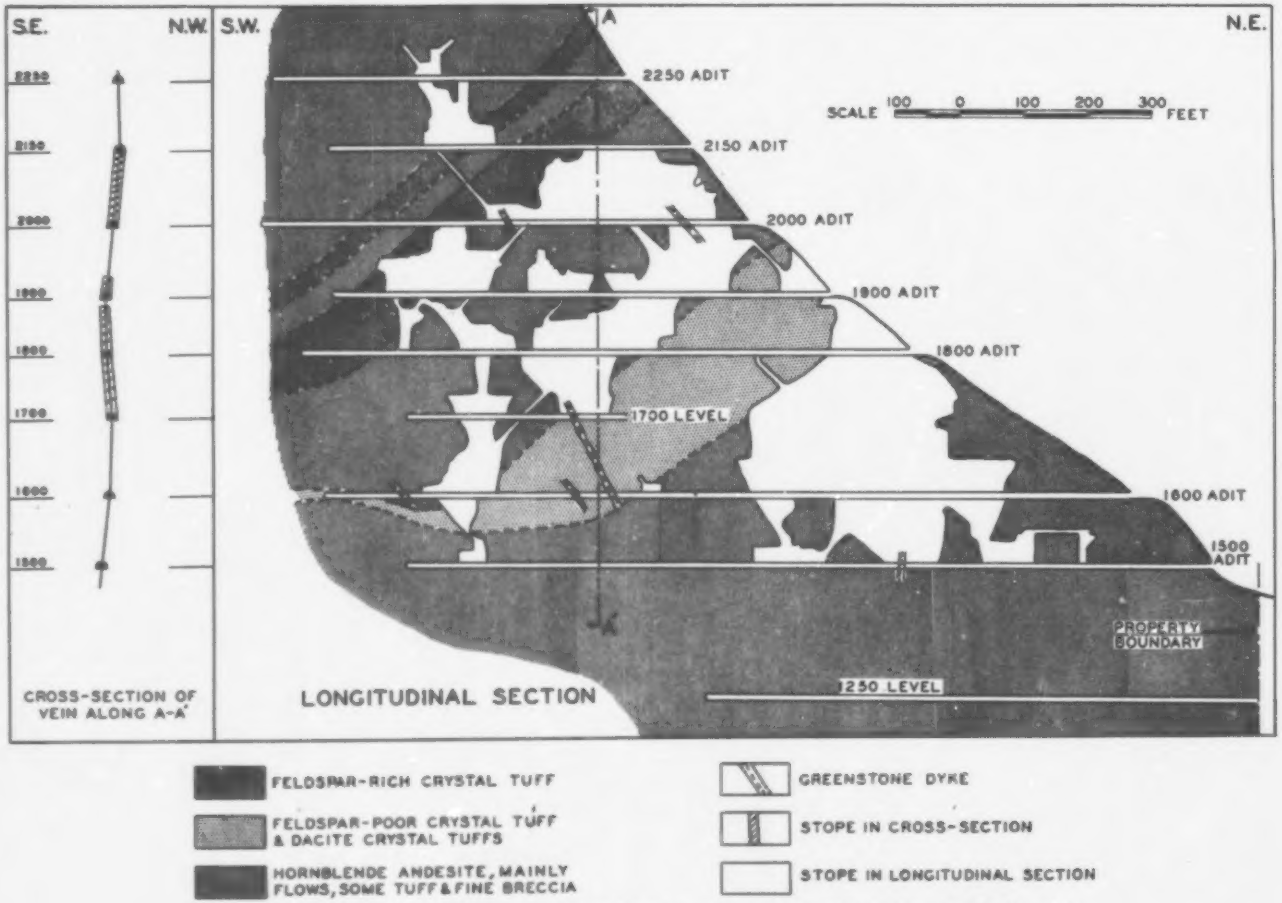
S.E.
N.W.
2250
2150
2000
1900
1800
1700
1600
1500
CROSS-SECTION OF VEIN ALONG A-A'
S.W.
N.E.
A
A'
2250 ADIT
2150 ADIT
2000 ADIT
1900 ADIT
1800 ADIT
1700 LEVEL
1600 ADIT
1500 ADIT
1250 LEVEL
PROPERTY BOUNDARY
SCALE
100
0
100
200
300
FEET
LONGITUDINAL SECTION
FELDSPAR-RICH CRYSTAL TUFF
FELDSPAR-POOR CRYSTAL TUFF & DACITE CRYSTAL TUFFS
HORNBLENDE ANDESITE, MAINLY FLOWS, SOME TUFF & FINE BRECCIA
GREENSTONE DYKE
STOPE IN CROSS-SECTION
STOPE IN LONGITUDINAL SECTION

Fig. 20. Mount Zeballos: Cross-section and longitudinal section of the Mount Zeballos vein, showing stoped areas and geology.

As descriptions of the geology and petrography of many of the rock types found in the area have already been given (pp. 16 to 36), only their local distribution and features which relate in particular to the Mount Zeballos mine will be given here.

Excepting minor diabase dyke rocks, the rocks at Mount Zeballos are of volcanic origin (Fig. 19). The volcanic rocks include fine-grained brownish feldspar-poor crystal tuffs, coarser-grained grey feldspar-rich crystal tuffs, white dacite tuffs and flows, and dark-green andesitic flows and tuffs, all of which strike northwesterly and dip southwestward.

A section across the strike of the rock formations is shown by the longitudinal section of the vein in Figure 20. Lime-silicate rocks similar to those at the Privateer mine are not abundant at Mount Zeballos, but a few thin beds and zones or patches of lime silicates in the volcanic tuffs suggest a moderate original content of calcareous material in these rocks, and therefore a stratigraphic correlation with the Privateer band of lime-silicate sediments.

Thick massive beds of feldspar crystal tuff, 30 to 100 feet thick, are found on the surface and in nearly all the levels (Figs. 19 and 20). Grey feldspar-rich crystal tuff is found on the surface, on the 1800, and the other adits above it. Brownish-grey feldspar-poor crystal tuff is found underground and on the 1600, 1700, 1800, and 1900 adits.

White dacite tuffs (Plate IV) and flows are found in the two adits on the Farris vein and in the 1600 and 1800 adits on the Mount Zeballos vein (Fig. 19).

Green andesitic lava, with some green volcanic breccia both above and below the tuffs, is the main rock on the hillside and is found in all the adits.

Breccia zones, characterized by apple-green alteration, are found in the greenstone volcanics in all the levels. These zones are from 1 to 12 feet wide. They are apparently beds of green volcanic breccia more porous than most of the rocks found on the property and therefore more amenable to alteration. The breccia zones all conform to the general strike and dip of the associated rocks. The most conspicuous breccia zones consist of large elliptical masses, up to 8 inches by 12 inches, of white dacite lava set in a matrix of fragmented green volcanics. The dacite lava contains a moderate to large amount of quartz occurring as parallel-oriented quartz eyes. Smaller fragments of dacite, one-eighth of an inch to one-half an inch in diameter, are found in some zones. Other breccia zones in the greenstone do not contain the conspicuous pieces of dacite but are marked by light apple-green cusp-shaped altered patches. Close examination shows that the matrix of these patches is definitely fragmental. The alteration is secondary but was undoubtedly localized by the porous nature of the volcanic breccia.

In the adits on the Farris vein, a dacite volcanic breccia is found adjacent to white porcelainous dacite tuff. The breccia is just a coarser phase of the tuff found in these adits.

Hornblendite is found underground in the adits on the Farris vein and in the 2000 and 1900 adits on the Mount Zeballos vein. The hornblendite is massive, dark green, and medium grained, and under the microscope is seen to consist mainly of hornblende. It conforms in strike and dip to the enclosing rocks, but a fine-grained border up to 1 foot thick suggests that it intrudes them. The hornblendite probably comprises sills in the flows and tuffs.

Several diabase dykes, 6 inches to 5 feet wide, cut the volcanics and are cut by the vein shears. As the scattered nature of outcrops and lack of contacts on the hillside prevent recognition of the dykes on the surface, they are only recognizable underground. Most of the dykes strike northerly to northwesterly and range in dip from eastward to westward.

Veins.—Two veins, the Mount Zeballos and the Farris (Fig. 19), have been developed on the property, but ore has been produced from the Mount Zeballos only.

The Mount Zeballos vein (Figs. 19 to 21) follows a narrow but well-defined shear, strike north 43 to 45 degrees east and dip vertical to 70 degrees southeastward. The vein shear ranges in width from one-eighth of an inch to 2 feet and is well defined, even where very narrow.

The predominantly straight, single break is modified by branches that come off to form either a closed loop or a diagonal. A branch may leave the vein at a small angle, follow a course 2 to 3 feet from the vein, and rejoin it 10 to 40 feet along the strike. In a few places the main break is parallelled by another break 2 to 4 feet away. On some levels, diagonal crush zones join these parallel breaks. The diagonal crush zones are up to 2 feet wide and offset the vein up to 10 feet. The vein quartz extends along these diagonals from one shear to the adjacent parallel one and follows the crush zone for 10 to 20 feet along the course of the vein. In some levels the vein shear crosses zones of closely spaced joints from 1 inch to 2 feet apart, strike north 80 to 85 degrees east and dip vertical. These do not offset the vein, although in a few places vein quartz has spread out along the joints.

A few cross-faults, containing half an inch to 8 inches of crushed rock, offset the vein but not by more than 2 feet. The displacement of the vein is not in the same direction on all cross-faults. Several of the cross-faults are localized along the contacts between the various rock types. Numerous gouge slips along and in the vein quartz indicate post-mineral strike faulting.

Offsetting of formations on either side of the vein indicates that the northwest side of the vein moved northeasterly from 10 to 28 inches. However, northwesterly striking and northeasterly dipping dykes on the 1600 level have been offset in the opposite direction, and northwestern continuations across the vein have been moved 14 inches southwesterly. Therefore, the actual movement must have been nearly vertical, with the northwestern side going down about 14 inches.

The vein matter in the shear consists usually of ribbon quartz, ranging in width from a few inches to 10 inches, with a width of from 2 to 3 inches being the most common. Where the width of quartz is less than 2 inches, ribbons are absent. The quartz tends to be brecciated where a change in strike occurs. The angular fragments in the breccia may be altered and may contain pyrite cubes, or they may have been replaced by quartz and be recognizable as patches of cloudy grey quartz in a matrix of clear white quartz. Inclusions up to 1 inch in diameter have been found in 10-inch widths of quartz and up to half an inch in diameter have been found in 2-inch quartz veins.

A comb texture with coarse carbonate in the centre of the vein moulded around the ends of the quartz crystals is found occasionally in the quartz. Locally, the vein consists of quartz, which has completely replaced the shattered rock of the shear zone, and which is veined by white quartz of a later generation. Such silicified sections are most common along diagonal crush zones that connect and offset the continuation of the main vein.

The vein quartz contains finely divided arsenopyrite and pyrite as fine-grained aggregates that form the ribbons of dark mineral in the quartz. Buff-weathering ankeritic carbonate occurs as small lenses, about 1 inch by 10 inches, that fill the centre of the vein where crustiform. The carbonate is coarsely cleaved, with cleavage surfaces as large as 1½ inches. This carbonate seems to be most abundant in the upper levels, although small amounts are found on the 1250 level.

Fine-grained white calcite veinlets cut fractured quartz and cement fault material of some of the late faults; consequently, the calcite is definitely later than the vein mineralization.

The rock in the vein shear is usually bleached to a light buff and contains pyrite cubes one-third to one-eighth of an inch on the side. Even where there is very little crushing or shearing and the vein break is represented only by a slip, the rock may be altered for as much as 6 inches from the slip. The dark-green volcanic rock has been bleached to a light buff-grey and consists mainly of a felted mass of sericite and carbonate with scattered crystals of cube-pyrite. The coarse crystal tuff has been altered, for as much as 2 feet from the vein, to a white granular rock consisting mainly of sericite, carbonate, and cube-pyrite.

None of the faces in which work was stopped in 1942 appear to be in ore. Towards the southwest faces of the drifts and below the stoped area, as on 1250, the vein pinches to a discontinuous stringer of quartz or of calcite in a narrow shear, frequently only a fraction of an inch wide. Despite the narrowness of the vein, the vein shear is persistent and may extend southwesterly a considerable distance beyond the present faces. A vein, approximately on the strike and explored over the ridge in a short adit, elevation 2,365 feet on the " J " claim, may be the southwestern continuation of the Mount Zeballos vein. This working follows a vein shear, first as an open-cut for 12 feet, then underground for 16 feet. The shear is 1 to 4 inches wide and consists mainly of gouge with a little calcite and a smaller amount of quartz. This is not the " J " vein to be described below.

The Farris vein shear (Fig. 19) is a narrow break, half an inch to 3 inches wide, that contains a discontinuous ribbon of quartz half an inch wide. At three places in the upper or 1900 adit the vein shear and quartz change their strike to follow vertical joints for 15 to 30 feet, strike north 77 degrees east.

A rusty gouge seam, half an inch to 1 inch wide and lacking quartz, is characteristic of long sections of the vein. The wallrock is slightly sheared or broken on either side of the vein for 6 inches to 2 feet. Where the shear narrows to the width of a knife-edge, its course is not particularly straight, and it is not a clean-cut break. In places some alteration is found along the shear. The vein matter consists of grey quartz finely banded with fine-grained sulphides. A little coarse calcite is also present.

Southwesterly over the ridge a vein, referred to as the " J " vein, strike north 58 degrees east and dip vertical, has been followed northeasterly by an adit, elevation 2,300 feet on the " J " claim, for 190 feet (Fig. 19) and by surface cuts for 285 feet northeasterly up the hillside from the portal of the adit. The vein, 2 to 10 inches wide, consists of quartz mineralized with fine-grained pyrite and arsenopyrite. At several places the vein quartz contains numerous angular fragments of green volcanics. The rock in the adit is green andesite tuff except for two feldspar porphyry dykes, the width of one extending for 25 feet from the portal and of the other for 125 to 145 feet from the portal. The dykes strike northerly and dip 60 degrees westward.

Structural Controls in Localization of Veins and Ore.—The Mount Zeballos veins (Figs. 2 and 19), strike north 52 degrees east and dip vertical, are at a flat S-bend in a band of crystal tuff and lava about 750 feet wide that strikes northwesterly and dips southwestward. As the veins are perpendicular to the S-bend at the places of maximum curvature, the vein fissures probably formed as tension breaks at these places of maximum curvature.

Within the main or Mount Zeballos vein (Fig. 20) the ore is in green hornblende andesite lava that lies between overlying feldspar-rich crystal tuff and underlying feldspar-poor crystal tuff and dacite, and in green hornblende andesite lava where immediately underlying the crystal tuff. No ore has been found lower in the lava where it has been prospected by the 1250 level.

Although the deflections of the vein in passing from one rock type to another are not enough to be seen on the drawings of the mine, they may be large enough for movement of the walls of the original fissure to have produced openings where the fissure cut lava adjacent to recrystallized tuff. Inasmuch as openings in veins decrease the velocity of moving solutions, they are thought* to be favourable places for precipitation of vein matter and therefore favourable for the formation of orebodies. Such conditions probably account for the localization of ore in the lavas where adjacent to recrystallized tuff and, to a less marked degree, account for the localization of one oreshoot in lava immediately above the only slightly recrystallized crystal tuff.

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* Lovering, T. S.: Physical factors in the localization of ore, *in* Ore deposits as related to structural features, Princeton University Press, 1942, p. 6.

Spud Valley.* This property, at the head of Spud Creek, is owned by Spud Valley Gold Mines, Limited, 703 Royal Trust Building, Vancouver. P. F. Knight, president; Dale Pitt, managing director; and W. Elliott, mine manager. The property includes the Crown-granted claims Goldfield (L. 1020), Last Chance (L. 1021), A.T. No. 2 Fraction (L. 1022), Gold Spring (L. 1023), Linton (L. 1024), Linton No. 2 (L. 1025), A.T. Fraction (L. 1026), Anvil (L. 1027), Spud (L. 1028), A.T. No. 1 (L. 1029), A.T. No. 6 Fraction (L. 1695), and Rimy No. 4 (L. 1903).

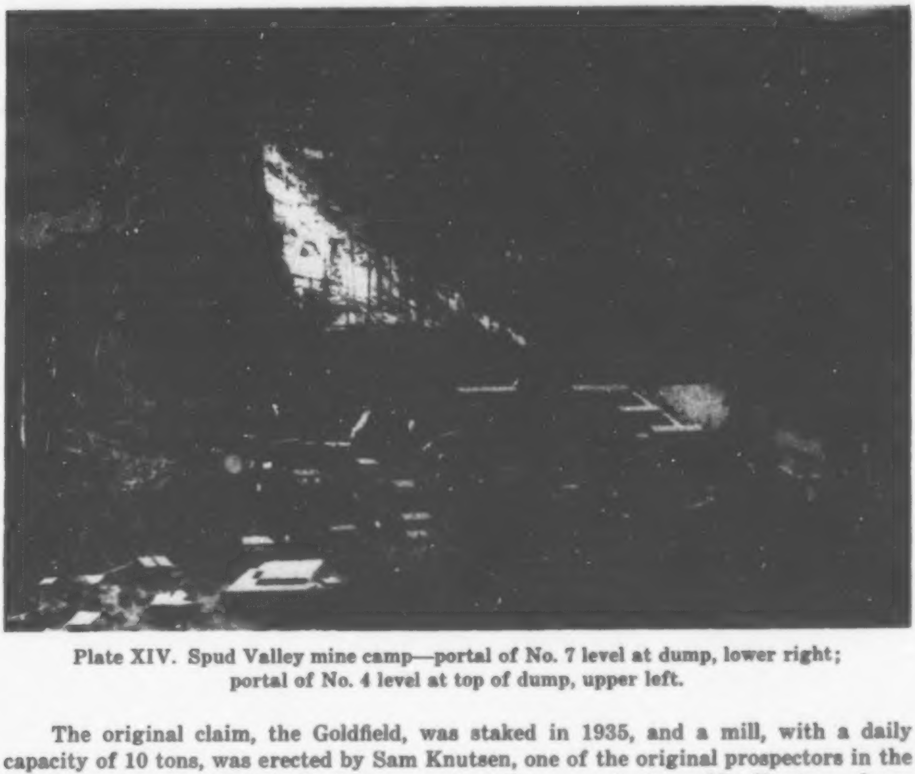

Plate XIV. Spud Valley mine camp—portal of No. 7 level at dump, lower right; portal of No. 4 level at top of dump, upper left.

The original claim, the Goldfield, was staked in 1935, and a mill, with a daily capacity of 10 tons, was erected by Sam Knutsen, one of the original prospectors in the Zeballos camp. In 1936 A. B. Trites acquired the property from Mr. Knutsen, drove the upper three levels, and built a small camp about 300 feet north of and at about the same elevation as the present No. 6 level. In 1937 Spud Valley Gold Mines, Limited, acquired the property from the Trites interests, continued underground work on the Goldfield vein, and commenced work on the Spur and Roper veins. The company built the present camp and, late in 1938, the mill. The mine was closed in 1942, and a watchman was retained on the property. Although the company has since started work on the property of its wholly owned subsidiary, Big Star Gold Mines, Limited, no further work has been done on the veins at the Spud Valley mine.

The mine workings (Fig. 22) include several adits with connecting raises. In 1942 most of the ore was being delivered through an ore-pass to No. 7 level and trammed to the mill, but prior to the driving of No. 7 level it had been conveyed from the portal of No. 4 adit to the mill by an aerial tramway 1,200 feet long.

The mill employed both amalgamation and flotation, had a crushing capacity of 250 tons, and a milling capacity of 125 tons in twenty-four hours. About half of the ore mined was discarded from a picking-belt before milling; concentrates amounted to 2½ to 3 per cent. of the tonnage milled. In 1942 slightly over half of the ore mined was being discarded as waste, after crushing, but much of this was from the Big Star property on Goldvalley Creek, where bad sloughing caused dilution of the vein matter.

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* *See* Figures 22 and 23 in pocket and Figure 24 in text.

Production and operation data for the entire life of the mine are given in the following table. About one-quarter of the gold and half of the silver were recovered in concentrates and the remainder in bullion.

Production and Operating Data, Spud Valley Gold Mines, Limited.[1] [2]

	Ore mined.	Ore treated.	Gold, Gross.[3]	Silver, Gross.[3] [4]	COSTS PER TON MILLED.[5]		
					Development and Exploration.	Mining.	Milling.
	Tons.	Tons.	Oz.	Oz.	$	$	$
1936	4[4]	....	47[4]	17	....	....	....
1938	1,900[7]	1,702	473	171	....	....	....
1939	35,607[6]	20,950	15,369	4,779	....	[8]	....
1940	56,184[6]	28,426	18,099	5,501	....	....	....
1941	72,943[6]	34,549	14,031	6,004	0.70	7.25	2.71
1942[8]	20,060[6]	20,060	6,020	2,003	0.584	5.587	2.369
Weighted average[9]	....	....	....	....	0.66	6.63	2.58
Totals	186,698	105,687	54,039	18,475	....	....	....

[1] Information, except where noted, from Yearly Summary Reviews of the Gold Mining Industry in Canada, published by Dominion Bureau of Statistics, Ottawa.

[2] Production includes about 15,000 tons of sorted ore from the Big Star operation.

[3] Total metal content in bullion and concentrates as determined by settlement assay.

[4] Information from British Columbia Bureau of Economics and Statistics and British Columbia Department of Mines.

[5] Figures do not include taxes or head office, marketing, depreciation, and depletion charges.

[6] Mine-run ore, includes waste discarded on picking-belt.

[7] Estimated from ore treated.

[8] Information not available.

[9] Weighted for variation in yearly tonnage.

No rock types other than quartz diorite are found on the property (Fig. 2), except for a few spindle-shaped feldspathized inclusions in the quartz diorite and a diabase dyke 2 feet wide on the No. 7 level.

Three main veins, the Goldfield, the Spur, and the Roper, have been developed on the property.

The Goldfield vein, strike north 50 to 62 degrees east and dip 75 to 85 degrees northwestward, ranges in width from a fraction of an inch to 16 inches and usually is from 6 to 8 inches wide. It follows a well-defined shear zone that is a few inches to 2 feet wide. In places the shear zone passes along the strike into a sheeted zone that consists of joints spaced 4 to 18 inches apart and spread over a width of from 4 to 12 feet. Such joints frequently contain quartz ranging in width from half an inch to 2 inches. Along some sections of the vein, particularly towards the southwestern end, the only evidence of the vein is a stringer of quartz an eighth of an inch to half an inch wide, which follows a jagged fracture in the rock. In many places diagonal quartz stringers, which strike more easterly than the main vein and dip vertically, range in width from half an inch to 4 inches and cross from one wall of the vein shear to the other.

Much of the vein quartz is firm and is ribboned by thin stringers of sulphides, but some of it is friable and consists of loosely aggregated crystals. Between the ends of these crystals, pyrite, sphalerite, and galena are frequently found. In the diagonals, sulphides are not abundant, and the quartz is usually coarsely crystalline with a well-developed comb texture.

Some diagonal quartz stringers cross the main vein shear, and many diagonal joints, some of which contain quartz a fraction of an inch thick, lead into the walls from the main shear. Both the diagonal quartz stringers and the quartz-filled joints are short and usually have frozen walls, suggesting an origin by tension rather than by shear. They both strike more easterly than the main vein shear and dip vertically, which indicates that the hangingwall of the main vein shear moved northeasterly and down with respect to the footwall.

The Goldfield vein is not cut by any cross-faults, but on Nos. 6 and 7 levels a strong fault comes into the north wall of the drift at a small angle, and going northeasterly along the drift the fault is close to the vein for some distance before actually joining and following it to the northeastern faces of these drifts.

Movement along the vein shear, though not great, has been intense. Slips cut the ends of diagonal veins and slice the quartz of the main vein into disconnected lenses. In places within the vein shear, crushing has reduced the quartz to sugary masses and the sulphides to masses of black powdery material.

Quartz-sulphide vein matter, although narrow, assayed high in gold. A sample taken by the writer in 1935 from the original open-cuts on the Goldfield vein across 1 foot of quartz and sulphides assayed: Gold, 7.32 ounces per ton; silver, 2.6 ounces per ton. A sample taken across 9 inches of rusty quartz assayed: Gold, 5.40 ounces per ton; silver, 2 ounces per ton. A sample taken in 1938 (Stevenson, Lode-gold Deposits, 1938, pp. 17, 18) 100 feet from the northeastern portal of No. 2 adit across 4½ feet of sheeting that included quartz-filled joints 2 to 6 inches apart and an eighth of an inch to half an inch wide assayed: Gold, 8.30 ounces per ton; silver, 2.5 ounces per ton. A sample taken 276 feet from the northeastern portal of No. 2 adit along 2 feet of quartz pyrite 4 inches wide assayed: Gold, 13.20 ounces per ton; silver, 6.5 ounces per ton. Much of the vein quartz contains less sulphide than the above samples and contains correspondingly less gold.

Numerous slabs of barren rock that were breaking at gouge seams sloughed into stopes, thus lowering the grade of mine-run ore.

Ore mined from the Goldfield vein amounted to 70,000 tons and ranged from 0.10 to 1.86 ounces of gold per ton, with an average grade of about 0.34 ounce of gold per ton.

The Spur vein (Figs. 22 and 24), strike north 70 degrees east and dip 85 degrees northwestward to vertical, branches from the southeastern side of the Goldfield vein and has been followed by drifting on Nos. 1 to 6 levels and stoped on Nos. 1 to 5 levels.

The structure and texture of the vein quartz are similar to that of the Goldfield vein. However, the widths of the shear zone and of the vein quartz in it are less than in the Goldfield vein. Although the width of quartz in places is as much as 1 foot, the average width is less than 6 inches. Some short sections of very high-grade ore assaying up to 20 ounces in gold per ton have been found, but, on the whole, the vein is poorer than the Goldfield. The sections of high-grade ore were found at varying distances from the Goldfield vein and do not seem to bear any relation to the intersection of the veins. The vein is straight and varies less in strike and in dip than the Goldfield.

The northeastern end of the Spur vein, as seen in the drift faces, is only half an inch of gouge and a quarter of an inch of quartz and sulphides.

Towards its southwestern end, near its intersection with the Goldfield vein, the Spur vein narrows to a shear 1 inch wide containing quartz one-quarter of an inch to half an inch wide.

Diagonal quartz veins up to 2 inches wide, striking more northerly and dipping less steeply than the Spur vein, indicate that its northwestern wall moved southwesterly and down with respect to the other wall. This is the opposite of the movement on the Goldfield and suggests that locally the Goldfield and Spur veins constitute the two

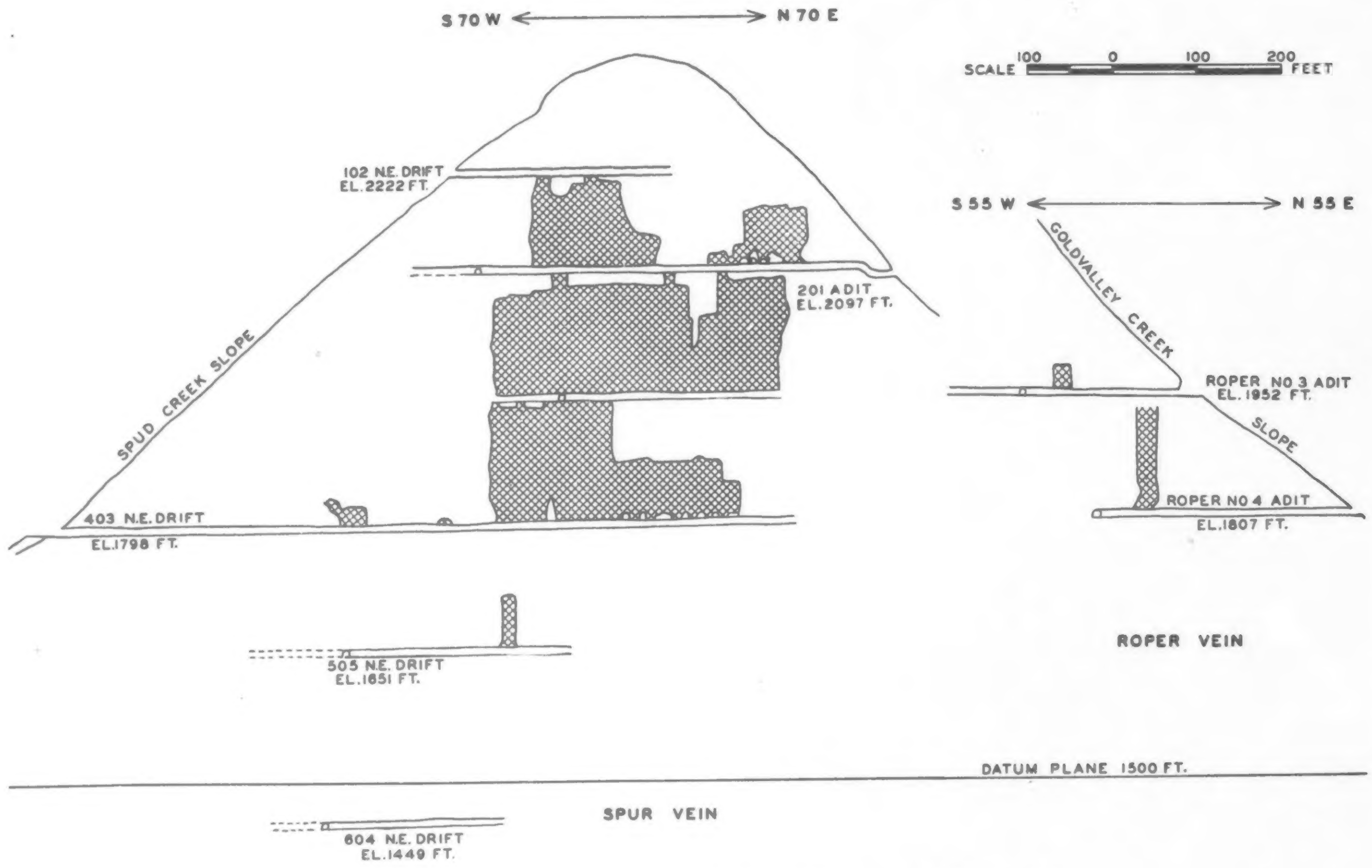
S 70 W
N 70 E
SCALE
100
0
100
200
FEET
102 NE. DRIFT
EL. 2222 FT.
201 ADIT
EL. 2097 FT.
SPUD CREEK SLOPE
403 N.E. DRIFT
EL.1798 FT.
505 N.E. DRIFT
EL. 1651 FT.
S 55 W
N 55 E
GOLDVALLEY CREEK
ROPER NO 3 ADIT
EL. 1952 FT.
SLOPE
ROPER NO 4 ADIT
EL. 1807 FT.
ROPER VEIN
DATUM PLANE 1500 FT.
SPUR VEIN
604 N.E. DRIFT
EL. 1449 FT.

Fig. 24. Spud Valley: Longitudinal projection of the Spur and Roper veins, showing stoped areas.

planes of maximum shearing stress, with the Goldfield vein following the direction of stronger and the Spur vein the direction of weaker shearing respectively.

Production from the Spur vein, including wallrock, which sloughed into stopes, was 26,600 tons, averaging 0.28 ounce of gold per ton.

The Roper vein is 520 feet southeasterly from the Goldfield vein. It strikes north 60 degrees east and dips 85 degrees northwestward. It is parallel in strike but steeper in dip than the Goldfield.

Two drifts have been driven on the vein, and a small stope has been made on each level.

The Roper vein (Figs. 22 and 24) consists of quartz up to a foot wide, but usually about 2 inches wide, in a shear zone up to 2 feet wide. The quartz contains ribbons of fine-grained sulphides, usually pyrite and arsenopyrite. Vein matter near the portal is reported to have assayed several ounces in gold per ton, but elsewhere it assayed less than half an ounce per ton. For short sections the quartz vein matter gives way to crystalline calcite with cleavage fragments up to an inch long.

From the upper drift a crosscut 15 feet long intersects a branch vein, strike north 67 degrees east and dip vertical, that consists of quartz up to 3 inches wide in a crush zone 1 to 6 inches wide. Ore in this vein yields less than a third of an ounce of gold per ton.

Structural Controls in Localization of Ore.—The Goldfield, Spur, and Roper veins are wholly within massive quartz diorite, and it is difficult to demonstrate that local rock structures determined the localization of oreshoots in them.

However, the workings on the Goldfield vein are sufficiently extensive to permit a structural analysis of the vein and to determine favourable changes in its dip and strike following the method of analysis outlined by Newhouse.*

The Goldfield vein occupies a narrow well-defined shear that strikes north 50 to 62 degrees east and dips 75 to 85 degrees northwestward (*see* Fig. 22). Numerous joints, short gash veins, and one persistent vein, the Spur vein, branch from the main vein, with an average strike of north 70 degrees east and dip from 85 degrees to vertical. These are probably tension breaks formed by movement along the main vein shear, and, because of their more eastern strike and steeper dip, they indicate that the hangingwall of the main vein shear moved northeasterly and down with respect to the footwall, and that the vein therefore occupies a normal fault.

Newhouse† has shown, by drawing contours on curved planes and on composite mine plans, and it is generally conceded, that in a vein occupying a normal fault, openings and orebodies form in the more steeply dipping parts. It may be seen in Figure 22 that the main stoped area on the Goldfield vein lies above No. 5 level in the more steeply dipping portion of this vein. Again, in the figure, it may be seen that the vein-contours converge—that is, the vein steepens—at the northeastern end of the stoped area above No. 5 level and that this convergence or steepening trends southwesterly across the stoped area from the northeast end of Nos. 1, 2, and 3 levels to the southwest ends of Nos. 3, 4, 5, and 6 levels. Smaller stoped areas, separate from the main stoped area above No. 5 level, are found where contours in southwest portions of Nos. 6 and 7 levels converge locally. That is, the orebodies are where, according to the theory outlined, the changes in dip and strike indicate that openings would occur along a curving normal fault.

Britannia M. This group includes the M-1 (L. 1065), M-2 (L. 1066), M-3 Fraction (L. 1067), M-4 (L. 1068), M-5 (L. 1070), and M-6 Fraction (L. 1069) Crown-granted claims, staked in 1935, brought to Crown grant in 1939, and owned by Britannia Mining and Smelting Co., Limited, Britannia Beach. The property is on the northeast side of Spud Creek (Fig. 2) and is adjacent to the south-

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* Newhouse, W. H.: Openings due to movement along a curved or irregular fault plane; *Econ. Geol.*, Vol. XXV, 1940, pp. 445–464.

† Newhouse, *op. cit.*, pp. 447–453.

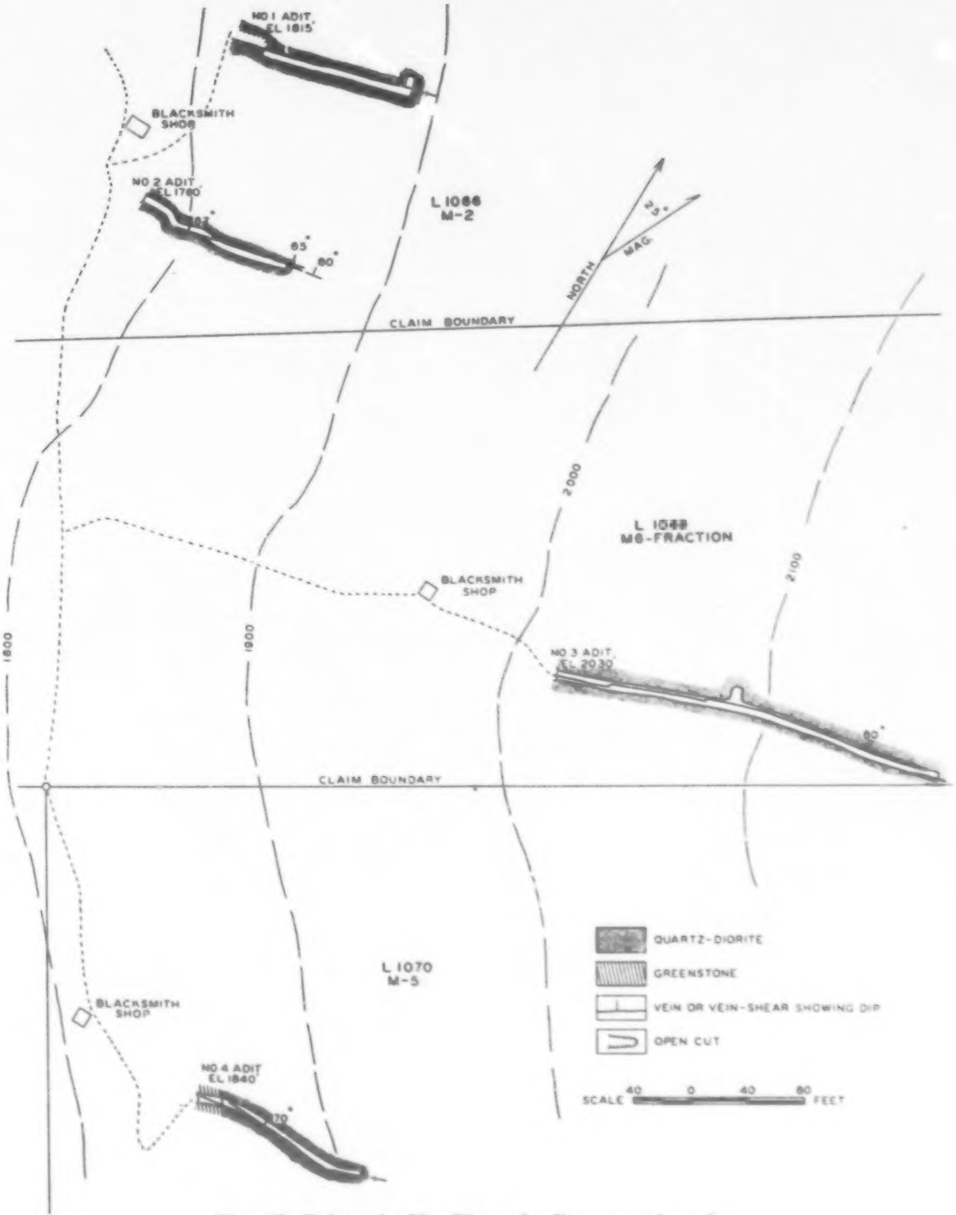

NO 1 ADIT
EL 1815'
BLACKSMITH SHOP
NO 2 ADIT
EL 1760'
82°
65°
80°
L 1066
M-2
NORTH
MAG
25°
CLAIM BOUNDARY
2000
L 10[illegible]
M6-FRACTION
2100
BLACKSMITH SHOP
1800
1900
NO 3 ADIT
EL 2030'
80°
CLAIM BOUNDARY
L 1070
M-5
BLACKSMITH SHOP
NO 4 ADIT
EL 1840'
70°
QUARTZ-DIORITE
GREENSTONE
VEIN OR VEIN-SHEAR SHOWING DIP
OPEN CUT
SCALE
40
0
40
80
FEET

Fig. 25. Britannia M: Plan of adits on main veins.

eastern side of the property of the Spud Valley Gold Mines, Limited. Access to the camp is by a foot-trail, now overgrown and in disrepair, leading southeasterly from the portal of No. 7 adit of Spud Valley mine.

No work has been done since 1938. The writer examined the property in 1946 without the assistance of a guide.

The claims lie across the contact between quartz diorite on the northeast and andesite on the southwest (Fig. 2). However, with the exception of part of the vein in No. 3 adit (Fig. 25), all the veins are within the quartz diorite.

Eight quartz veins are reported to have been found on the property, of which the four main veins have been developed by adits (Fig. 25). The other four, on which little, if any, work was done, were not seen by the writer. The veins are vertical and strike easterly. The maximum width is 1 inch, and fairly continuous ribbons of quartz half an inch wide are common. The vein matter consists of quartz mineralized with fine-grained pyrite and some calcite. The shears followed by the veins range in width from one-quarter of an inch to 4 inches. In a few places the veins cross from one side of the shear to the other along a vertical diagonal and strike north 50 degrees east. The strike of these diagonal fractures indicates that the north side of the shear has moved west with respect to the south side, in accordance with the direction of movement in other easterly striking shears in the district (Fig. 3).

No. 1 adit, elevation 1,815 feet, follows a quartz vein from the open-cut at the portal to the face. The vein, a continuous ribbon of quartz half an inch to 1 inch wide and partly vuggy, contains thin streaks of fine-grained pyrite. Fifty-five feet from the portal of the adit the quartz vein goes northerly across the shear along a quartz diagonal, strike north 50 degrees east and dip vertical. The vein follows a straight, well-defined shear, 1 to 4 inches wide, which consists in most places of gouge and crushed wallrock, but in some places it passes into a few feet of sheeting along its strike.

No. 2 adit, elevation 1,760 feet, intersects a quartz vein 32 feet from the portal and follows it to the face. The vein, usually about half an inch wide, consists of quartz with a streak of pyrite one-sixteenth of an inch wide along the footwall. It follows a well-defined shear, 2 to 4 inches wide, that consists of gouge and crushed quartz diorite. At the face the shear divides into north and south branches, and the vein, which consists of a band of quartz three-quarters of an inch wide and a central band of calcite half an inch wide, follows the north branch.

No. 3 adit, elevation 2,030 feet, follows a well-defined and continuous vein shear, one-quarter of an inch to 3 inches wide, from the portal to the face. Quartz containing a little fine-grained pyrite is found in discontinuous masses that are less than an inch wide and make up about half the exposed length of the shear. At 37 feet and 105 feet from the portal, the main vein shear crosses the drift northward along diagonal joints that strike north 50 degrees east and dip vertically; at each place the southern band of the main vein shear continues for a few feet eastward before finally dying out. Near the portal there is a narrow shear along the north wall and a wider shear along the south wall. Near the face the wider shear contains quartz and gouge half an inch and 1 inch wide respectively. At 126 feet from the portal a crosscut 10 feet long has been driven northerly along two vertical calcite stringers spaced a foot apart.

No. 4 adit, elevation 1,840 feet, for its full length, follows a vein shear 2 to 4 inches wide. Near the portal and near the face the strike shows deflections of about 10 degrees. Vein quartz, fairly continuous along the shear, is usually less than half an inch wide. The rock, for a distance of 15 feet from the portal, is andesite cut by stringers of quartz diorite, and from there to the face is quartz diorite with up to 10 per cent. andesite inclusions. However, at 15 feet from the face the inclusions become more abundant.

PROPERTIES ON GOLDVALLEY CREEK.

Gold Creek Claims, Britannia Mining and Smelting Co., Limited.

The claims in these groups, staked between 1935 and 1937, are owned by Britannia Mining and Smelting Co., Limited, and include the Crown-granted claims B-1 (L. 1053), B-2 Fraction (L. 1054), B-3 (L. 1057), B-4 (L. 1059), B-5 (L. 1058), B-6 (L. 1060), B-7 (L. 1693), Roy (L. 1691), T (L. 1692), and W. Fraction (L. 1749). The claims cover ground along the lower reaches of Goldvalley Creek and continue downstream to Zeballos River. Their exact location is shown in Figure 2. The remains of the tent camp, used when the work was done on the property, are on the C.D. caterpillar-road at a point about 1,000 feet downstream from the C.D. camp.

The claims were actively prospected by the Britannia Mining and Smelting Company, and the veins were opened up by widely scattered strippings and trenches. In 1938 M. F. Bancroft examined the claims when they were being prospected and has described the showings completely (Bancroft, 1940, p. 22), as follows:—

> The mineralized veins on the property cut through all the bedrock formations. Thirteen veins in all had been uncovered by August, 1938, some widely scattered and others grouped fairly close together. They show varying widths of quartz, mineralized country rock, gouge, and sulphides. The prevailing strike of these veins is northeast and their dip to the southeast.
>
> Surface work has been done on the following veins, named in the order in which they occur on the property from north to south:—
>
> (1) River vein, strike north 45 degrees east, dip 60 degrees southeast; width 5 inches; quartz, calcite and sulphides, pyrite.
> (2) Garbo Trail vein, strike north 73 degrees east, dip 80 degrees southeast.
> (3) East to west vein.
> (4) Contact vein, strike north 55 degrees east, dip 75 degrees southeast; width 4 inches; pyrite, chalcopyrite, and oxidized quartz.
> (5) Wet Fraction vein, strike north 43 degrees east, dip 65 degrees southeast.
> (6) End vein, strike north 45 degrees east, dip 68 degrees southeast.
> (7) Easter vein, strike north 45 degrees east, dip 70 degrees southeast; mineralized, vuggy quartz.
> (8) Wet Gulch vein, strike north 54 degrees east, dip 62 degrees southeast; pyrite and chalcopyrite.
> (9) Footwall vein, strike north 60 degrees east, dip 70 degrees southeast; width 3 inches.
> (10) Gouge vein, strike north 60 degrees east, dip 70 degrees southeast.
> (11) Draw vein, strike north 45 degrees east, dip 56 degrees southeast; width 5 to 8 inches; pyrite, arsenopyrite, galena, and zinc blende.
> (12) Straight vein, strike north 55 degrees east, dip 66 degrees southeast.
> (13) Camp vein, strike east, dip 60 degrees south; width 2 inches; gouge.
>
> The End vein has been traced on the surface for 1,200 feet and the other veins for shorter distances. It is about 1,800 feet from the Contact vein to the Straight vein as they are exposed at the surface, that is, nine veins occur in a belt of that width. However, in the first 750 feet southeast from the Contact vein no less than seven of the northeast veins are included. The surface showings along these veins are typical of the gold sulphide veins of the district, and it is probable that some of them will prove of economic importance once they are opened up underground. Most of these veins are in the granodiorite, or, if not, will reach it at shallow depth.

Since Bancroft's examination, little work has been done on the showings. On the W. Fraction a wide shear zone, strike northerly and dip about vertical, in quartz diorite was explored in 1938 by an open-cut in the south bank of Monckton Creek, just below the foot-bridge on the trail to the old Central Zeballos camp on the Extension No. 7 claim.

C.D. (Rey Oro).

The C.D. Mining Company, Limited, c/o Locke, Lane, Nicholson, and Shepherd, 703 Rogers Building, Vancouver, owns the Crown-granted claims Lone Star (L. 1052), J. and E. (L. 1056), K. Fraction (L. 1751), and Axe Fraction (L. 1752) on Goldvalley Creek. The property was known first as the Lone Star, later as the Rey Oro, and latterly as the C.D.

The Lone Star claim was staked in 1934 by Alex. McDonald, the J. and E. in 1936 by Edward G. Brown, and the K. and E. Fraction in 1937 by H. E. Smith.

In 1937 Rey Oro Gold Mining Company, Limited, acquired the property and, under the managership of Edward G. Brown, built a camp, drove the 1200 adit level, and mined high-grade ore, some of which was shipped to Tacoma and the remainder treated in a small mill with a daily capacity of about 15 tons.

The present owners, C.D. Mining Company, Limited, acquired the property late in 1939 and in 1940 completed a tractor-trail of puncheon started by Rey Oro Gold Mining Company, enlarged the camp, sank a winze to the 1400 level, and drove the 1300 and 1400 levels from the winze. Instead of milling, this company shipped high-grade ore to Tacoma.

The mine was closed in August, 1941, and the mining plant and most of the camp buildings have been dismantled.

Production data for the entire life of the mine are given in the following table:—

*Production Data, C.D. (Rey Oro) Mine.**

	Ore mined.	Gold, Gross.†	Silver, Gross.†
	Tons.	Oz.	Oz.
1938 (March 1 to December 31)	2,250‡	1,162	204
1939	3,368‡	848	237
1940	1,675‡§	1,319	532
1941	180‡	1,336	463
Totals	7,473	4,665	1,436

* Data from British Columbia Bureau of Economics and Statistics and British Columbia Department of Mines.

† Total metal content in crude ore and bullion as determined by settlement assay.

‡ Mine-run ore, includes waste discarded.

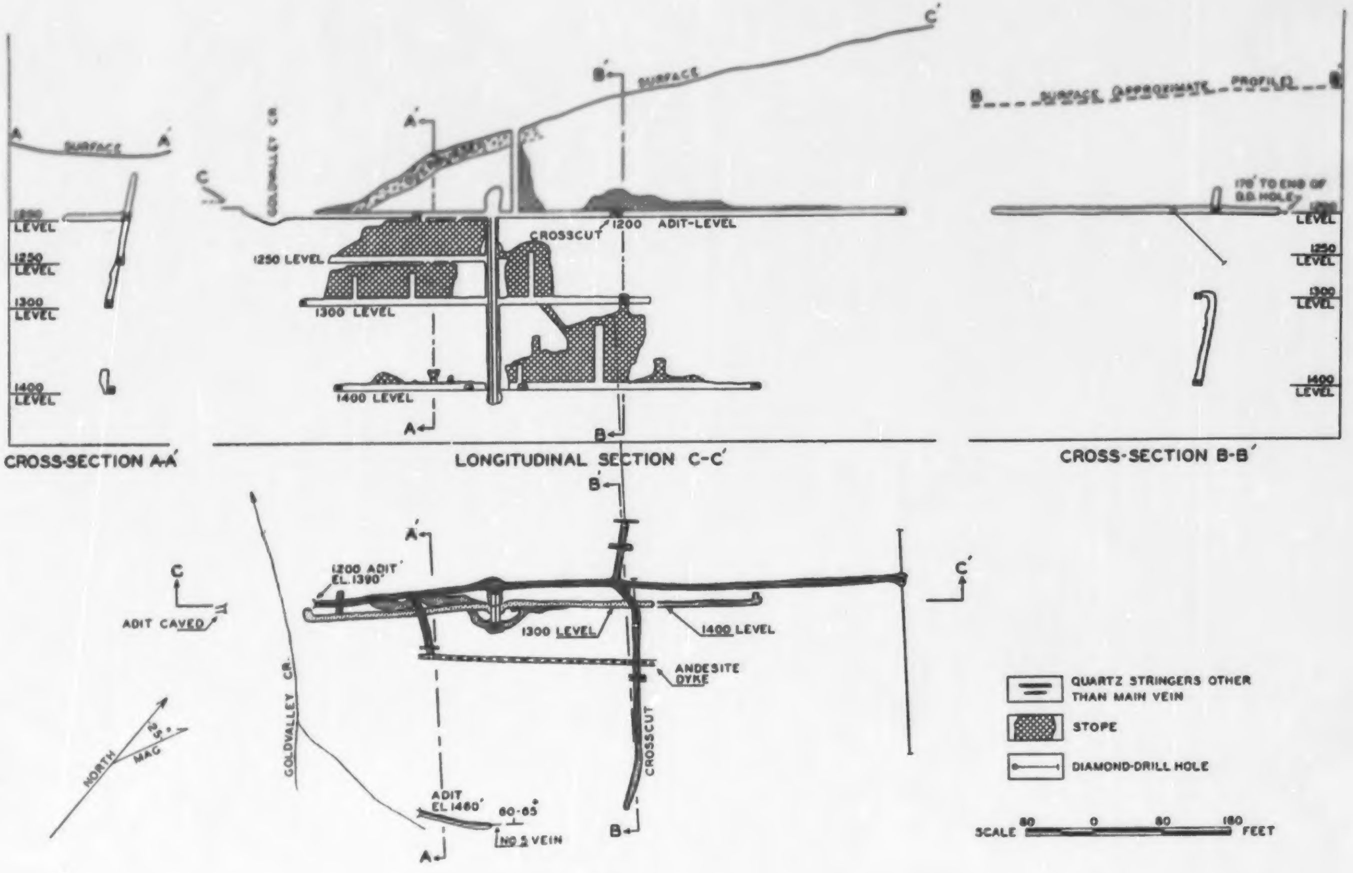
§ Includes 225 tons of crude ore shipped to smelter.

The workings on the main vein are shown in plan and section in Figure 26. The winze had not been sunk, and lower levels had not been driven when the property was examined in 1938. They were filled with water when the property was examined in 1945. The following descriptions refer only to the 1200 adit level and to the surface workings. The vein in the lower levels is reported to be similar in vein matter and in widths to that on the 1200 level.

The workings lie wholly within quartz diorite. An andesite dyke, 4 feet wide, strike north 50 degrees east and dip vertical, cuts the quartz diorite in the 1200 adit. The main vein strikes north 45 degrees east and dips 78 to 80 degrees southeastward. On the 1200 level the vein follows a shear that ranges in width from a few inches to 18 inches. The vein matter consists of quartz, usually with abundant sulphides, of which pyrite is dominant, and is accompanied by minor amounts of arsenopyrite, sphalerite, galena, and chalcopyrite. The vein matter had a maximum width of 5 inches and was not continuous along the vein shear. Long sections along the drift consist only of sheared rock and gouge.

In the 1200 adit level, quartz with abundant sulphides usually ran high in gold. A 4-inch sample of high-grade material (Stevenson, Minister of Mines, B.C. Ann. Rept., 1938, p. F 59) assayed: Gold, 4.24 ounces per ton; silver, 1.5 ounces per ton; lead, 0.5 per cent. One sample taken along a 2-inch ribbon of sulphides assayed: Gold, 13.2 ounces per ton; silver, 2 ounces per ton; lead, trace; zinc, 2.1 per cent.

The diagonal veins and joints that characterize the Spud Valley Gold Mines and Big Star veins are present but not numerous. Several diagonal joints, along which there has been alteration, were seen in the open-cut leading into No. 4 adit, and a quartz diagonal was seen 55 feet from the portal of the 1200 adit. This diagonal strikes east and is nearly vertical, thus indicating that the northwest wall or hanging-


A
SURFACE
A'
1200 LEVEL
1250 LEVEL
1300 LEVEL
1400 LEVEL
CROSS-SECTION A-A'
C
GOLDVALLEY CR.
A'
B'
SURFACE
C'
CROSSCUT
1200 ADIT-LEVEL
1250 LEVEL
1300 LEVEL
1400 LEVEL
A
B
LONGITUDINAL SECTION C-C'
B
SURFACE (APPROXIMATE PROFILE)
B'
170' TO END OF D.D. HOLE
1200 LEVEL
1250 LEVEL
1300 LEVEL
1400 LEVEL
CROSS-SECTION B-B'
B'
A'
C
ADIT CAVED
1200 ADIT EL. 1390'
1300 LEVEL
1400 LEVEL
ANDESITE DYKE
C'
NORTH
MAG
25°
GOLDVALLEY CR.
CROSSCUT
ADIT EL. 1460'
60-65°
NO. 5 VEIN
A
B
QUARTZ STRINGERS OTHER THAN MAIN VEIN
STOPE
DIAMOND-DRILL HOLE
SCALE 80 0 80 160 FEET

PLAN

Fig. 26. C.D. (Rey Oro): Composite plan of levels, longitudinal section, and two cross-sections on main vein, formerly known as No. 4 vein.

wall of the vein moved northeasterly and down with respect to the footwall in accordance with the displacement for most of the northeasterly striking veins in the camp (p. 45). Although the main C.D. vein contains abundant gouge and sheared rock and appears to be along the direction of maximum shearing, north 35 degrees east, for the camp, its strike is 10 degrees from this direction (Fig. 3) towards the more desirable direction of tension, north 62 degrees east.

On the 1,200-foot level several quartz stringers, parallel to the main vein, have been found in crosscuts northwesterly and southeasterly from the main drift (Fig. 26). These stringers range in width from 2 inches to less than a quarter of an inch and were not followed by drifts.

The main vein, No. 4, has been developed by the 1,200-, 1,300-, and 1,400-foot levels, which are connected by a winze and raises, and ore has been stoped from the surface to the 1400 level (Fig. 26).

Several other veins on the property have been explored by surface cuts, and No. 5 vein by a short adit (Fig. 26), but no ore has been mined from these veins. No. 5 vein, strike north 60 degrees east and dip 60 degrees northwestward, is a strong shear 1 to 18 inches wide with half an inch of quartz.

As little has been done on the other veins since they were examined in 1938, a description as at that time is quoted (Stevenson, Lode-gold Deposits, 1938, pp. 20, 21):—

> The showings, all on the north-easterly side of the creek, will be described consecutively up the creek from the one nearest the office.
>
> No. 1 is a stripping at an elevation of 1,315 feet and 220 feet in a direction south 55 degrees east from the office; it is 60 feet south-east from the foot-log across the creek. It is a stripping 10 feet long, exposing the junction of two joints, one of which strikes north 45 degrees east and dips 80 degrees south-east, the other north 33 degrees east and nearly vertical, in the quartz diorite; where they join the rock is fractured for a width of 1 foot; there is very little mineral in these joints.
>
> No. 2, 20 feet south-easterly from No. 1, is a stripping that exposes two or three veinlets, striking easterly, that range from ¼ to ½ inch in width and contain scattered grains of pyrite, arsenopyrite, and galena.
>
> No. 3, at an elevation of 1,325 feet and 210 feet in a direction south 28 degrees east from No. 1, is merely a showing that exposes a sheeted zone, strike north 50 degrees east, dip vertical, that is 18 inches wide and carries small amounts of arsenopyrite; although the rock immediately adjacent to the joints is somewhat leached, there is very little gouge developed.
>
> No. 4, at an elevation of 1,335 feet and 30 feet in a direction south 65 degrees east from No. 3, commenced as an open-cut and now (December 15th, 1937) an adit, 22 feet long, has been driven in a direction north 42 degrees east along a 1-inch quartz veinlet, striking north 42 degrees east and dipping 85 degrees south-easterly, that contains both grey massive and crustiform quartz with heavy pyrite and a little galena. In addition to the usual 1- to 2-inch zone of leaching on either side of the veinlet, there are recurring films of gouge. The same veinlet is exposed 25 feet south-westward from the portal, where it is of a similar character. It is to be noted that the north-westerly wall of this cut is broken by side-joints, and that each joint is filled with a thin seam of gouge and bordered by a ½-inch zone of leaching. A sample, taken along 2 feet of the ½-inch quartz-sulphide veinlet 20 feet outside the portal, assayed: Gold, 14.40 oz. per ton; silver, 5.6 oz. per ton. A sample from the face of the adit, consisting of a ¼-inch quartz-sulphide veinlet and 2 inches of leached quartz diorite, assayed: Gold, 0.01; silver, trace. Another sample of a ½-inch veinlet with no adhering quartz diorite assayed: Gold, 0.90 oz. per ton; silver, 0.1 oz. per ton. A sample of the quartz diorite alone that accompanied the last sample assayed: Gold, 0.06 oz. per ton; silver, trace.
>
> No. 5 showing, at an elevation of 1,420 feet and 260 feet in a direction south 60 degrees east from No. 4, is a combined adit and open-cut, the aggregate length of which is 34 feet. This working has been driven north-east for 34 feet along a curving shear that crosses and follows for short distances a series of joints that come into the shear at a small angle. The shear is widest in the face where it constitutes a zone 2 feet wide, and is cut by curving gouge-slips and so crushed that it is a mass of leached, disintegrated quartz diorite. The foot-wall shear in this zone strikes north 70 degrees east, dips 60 degrees north-westerly, and the hanging-wall shear strikes north 95 degrees east and dips 60 degrees north. The shear-zone is cut by a few criss-crossing stringers of quartz 1 to 2 inches wide, and containing small amounts of pyrite and arsenopyrite. In addition to the quartz in the face, the only other occurrence of appreciable size was a lens 2 feet long and 2 inches wide in the shear at

a point 18 feet from the mouth of the cut. Arsenopyrite and pyrite occur disseminated in small amounts in the vicinity of the 95-degree joints.

The following samples were taken in this cut and adit:—

(1) A bulk sample from a quartz-pyrite-arsenopyrite lens, 1 foot long by 2 inches thick, in the face, assayed: Gold, 0.10 oz. per ton; silver, trace.

(2) A sample of the abundant grey-black gouge, 2 inches thick, in the hanging-wall of the shear, assayed: Gold, 0.01 oz. per ton; silver, trace.

(3) A 14-inch channel sample taken across the back and consisting mostly of disintegrated quartz diorite assayed: Gold, 0.10 oz. per ton; silver, trace.

A small showing beyond the mouth of the cut and in the creek-bottom was seen to be a quartz veinlet ⅛ inch wide that contained abundant sulphide.

No. 6 is a showing in the bed of a branch creek, at an elevation of 1,500 feet and 660 feet in a direction south 85 degrees east from the office. It is a sheeted zone 18 inches wide formed by joints spaced 2 to 8 inches apart, each of which is accompanied by the usual leached border and disseminated pyrite. The only quartz occurs as discontinuous ½-inch stringers.

No. 7, or the McDonald stripping, in the bed of the same creek as No. 6, is at an elevation of 1,600 feet and is 220 feet in a direction north 80 degrees east from No. 6. This is a sloping stripping in the bed of the creek exposing a zone 12 to 18 inches in width and consisting of tight joints and a 2-inch blue quartz veinlet. Towards the upper end of the stripping the zone is more open and consists of alternating layers of gouge, crushed rock, and blue quartz veinlets; fine pyrite is abundantly disseminated through the quartz. A sample taken across 12 inches of the mixed material assayed: Gold, 0.01 oz. per ton; silver, trace.

Rimy.

This group is owned by Man-of-War Mines, Limited, 601–8 Bank of Toronto Building, Victoria, and consists of the Crown-granted claims Rimy No. 3 (L. 1765), Rimy No. 8 (L. 1766), Rimy No. 5 (L. 1767), Rimy No. 7 (L. 1768), Rimy No. 2 (L. 1769), Rimy No. 6 (L. 1901), and Rimy No. 1 (L. 1902), staked between 1934 and 1935 and brought to Crown grant in 1942.

The claims are east of Goldvalley Creek, easterly up the hillside from the C.D. property, and are reached by a good pack-horse trail from the C.D. mine (Fig. 2).

R. A. Pitre, W. J. Pitre, and Charles Henri staked the Rimy claims in 1934 and 1935. By 1938 Man-of-War Mines, Limited, had acquired the property, driven two main adits, and shipped 19 tons of development ore containing 44 ounces of gold and 51 ounces of silver. The company continued underground work until 1939, but since then no further work has been done. Only the development ore mentioned above has been shipped.

The property is wholly within quartz diorite, and the only other rocks on the property are a few northeasterly striking feldsphr porphyry and andesite dykes.

At least three veins have been found on the property, and adits have been driven on two of them.

The main vein has been developed by Nos. 3 and 4 adits (*see* Fig. 27). This vein, strike north 84 degrees west and dip 80 degrees southward, is 1 to 3 inches wide and follows a well-defined shear 1 to 10 inches wide. The vein matter consists of quartz with streaks of sulphides which include principally pyrite and arsenopyrite with smaller amounts of sphalerite and galena. Much of the vein matter in the two adits is strongly oxidized because a watercourse follows the vein fissure on the surface.

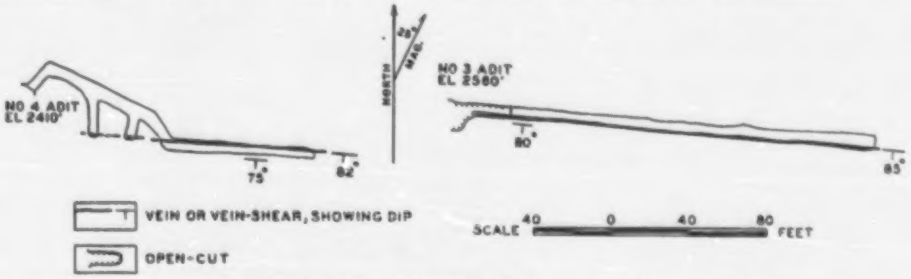


Fig. 27. Rimy: Plan of adits on main vein.

The vein usually lies near the footwall of the shear; towards the hangingwall it is succeeded by crushed rock or breccia and a fairly continuous film of black gouge. Samples of the vein matter have assayed from 0.1 to 9 ounces of gold per ton. A few northeasterly striking diagonal veins of comb quartz and sulphides lead from the main vein; this indicates that the north side moved west in a direction similar to the movement along other east-west breaks in the camp (p. 45).

The second vein has been explored by a short adit, known as No. 2, at an elevation of 2,140 feet and about 320 feet southwesterly from No. 4 adit. This adit has been driven north 5 degrees west for 41 feet to the face. Eighteen feet from the portal a drift extends easterly for 30 feet. The south wall of this drift follows a stringer of quartz and arsenopyrite from a knife-edge to 2 inches wide and is accompanied by 2 inches of gouge and crushed rock. Where the quartz and sulphides die out on the west wall of the entry crosscut and in the east face of the short drift, they are replaced by rusty gouge.

The writer did not see the third vein on the property, on which it is understood that very little work has been done.

Big Star Gold Mines, Limited.

This company, a wholly owned subsidiary of Spud Valley Gold Mines, Limited, 703 Royal Trust Building, Vancouver, owns several Crown-granted claims near the head of Goldvalley Creek. They include North Star (L. 1716), North Star No. 1 (L. 1717), Doolie Fraction (L. 1718), Golden Lode (L. 1720), Golden Spray (L. 1721), Golden Rocket (L. 1722), Nod Fraction (L. 1723), Don Fraction (L. 1724), A.T. No. 5 (L. 1725), Golden Nugget (L. 1747), and Golden Key (L. 1746).

The original claim, the North Star, was staked in 1937 by Sam Knutsen, and this and adjacent claims were acquired by A. B. Trites shortly thereafter. Big Star Gold Mines, Limited, was later formed to acquire the property from A. B. Trites, and in 1941 this company became a wholly owned subsidiary of Spud Valley Gold Mines, Limited. The property was commonly known as the North Star until 1940 and then as the Big Star. Preliminary work consisted of six open-cuts above the present adits. In the fall of 1937 work was started on No. 2 adit and subsequently on No. 3. Drifting and stoping on these two adits continued until the property was closed in June, 1942. In 1941 an aerial tramway, 3,000 feet long, was built from No. 3 level (elevation 2,399 feet) across the valley of Goldvalley Creek to the south end of a level track (elevation about 1,810 feet) that extends 1,000 feet southeasterly from No. 4 adit on the Goldfield vein of the Spud Valley mine. The mine is serviced by way of the Spud Valley tramway, No. 4 adit on the Goldfield vein, the above-mentioned surface track, and the Big Star tramway.

The mine was reopened in the spring of 1946, and work was started on a new adit, No. 5, 300 feet below No. 3 adit, to test the downward extension of shearing found in the upper workings. Late in 1946 a fire destroyed the living accommodation at the mine and work was suspended.

During the period of production from February, 1942, to July, 1942, about 15,000 tons of sorted ore, averaging about 0.27 ounce of gold per ton, is reported to have been milled.

As the property lies wholly within the main body of quartz diorite (*see* Fig. 2), quartz diorite is the main rock type found underground and near the workings, although Bancroft (1940, p. 26) noted an andesite dyke 12 feet wide at an elevation of 2,800 feet on the North Star claim.

The workings (Fig. 28) explore an easterly striking zone of shearing and cross-fracturing that ranges from a width of 50 feet at its western end, where it consists of north-south, east-northeasterly, and easterly striking fractures, to a width of 5 feet at its eastern end, where it consists principally of easterly striking fractures.

Frozen quartz-sulphide and quartz-calcite stringers cut the shear zone diagonally in an east-northeasterly direction. They range in width from a fraction of an inch to

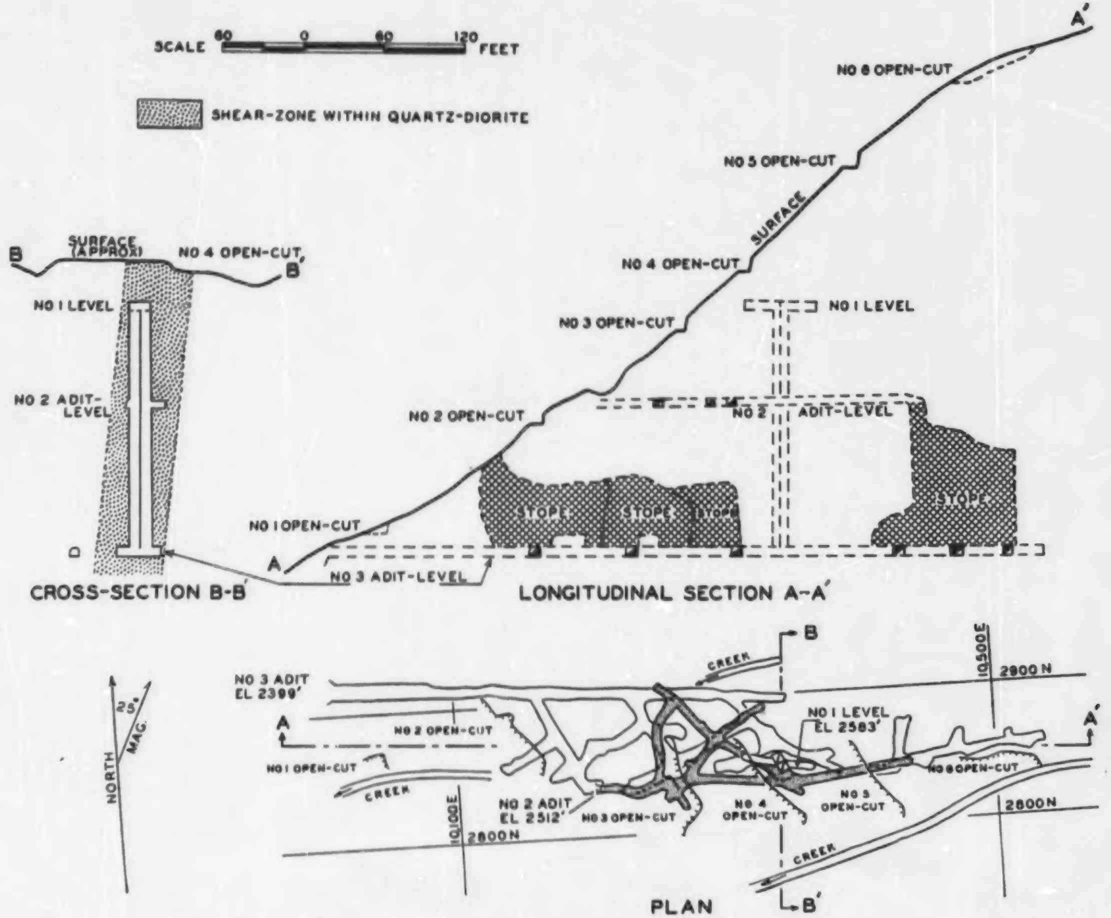

SCALE 60 0 60 120 FEET
SHEAR-ZONE WITHIN QUARTZ-DIORITE
A
A'
NO 6 OPEN-CUT
NO 5 OPEN-CUT
SURFACE
NO 4 OPEN-CUT
NO 3 OPEN-CUT
NO 2 OPEN-CUT
NO 1 OPEN-CUT
NO 1 LEVEL
NO 2 ADIT-LEVEL
STOPE
STOPE
STOPE
STOPE
NO 3 ADIT-LEVEL
LONGITUDINAL SECTION A-A'
B
B'
SURFACE (APPROX)
NO 4 OPEN-CUT
NO 1 LEVEL
NO 2 ADIT-LEVEL
D
CROSS-SECTION B-B'
NORTH
MAG.
25°
NO 3 ADIT EL 2399'
NO 2 OPEN-CUT
NO 1 OPEN-CUT
CREEK
10100E
2800N
NO 2 ADIT EL 2512'
NO 3 OPEN-CUT
NO 4 OPEN-CUT
NO 1 LEVEL EL 2583'
NO 5 OPEN-CUT
NO 6 OPEN-CUT
10500E
2900 N
2800N
CREEK
CREEK
PLAN

Fig. 28. Big Star: Plan, cross-section, and longitudinal section of workings.

about 3 inches and in length from a few feet to about 30 feet. The quartz, usually crystalline and vuggy, is along the walls of the stringers, and the sulphides are towards the centre of the stringers around the ends of the quartz crystals. Pyrite is the principal sulphide, with arsenopyrite occasionally present in large amounts and sphalerite and galena in smaller amounts. A specimen of quartz, with abundant sulphides, taken at the surface about 200 feet above No. 2 adit, is reported to have assayed 104 ounces in gold, and samples of quartz-sulphide stringers taken underground are reported to have assayed up to 4 ounces, although usually not more than 1 ounce in gold per ton. The quartz stringers are 1 to several feet apart, and as they are usually too narrow to be mined individually, several stringers, with the intervening wallrock, are mined; consequently, the value of such ground depends on the grade and closeness of the stringers. The ore, as mined in 1942, is reported to have averaged about 0.135 ounce of gold per ton.

Gouge seams, some of which contain calcite, occupy the vertical fractures. These cut the east-northeasterly striking quartz stringers but do not offset them appreciably. Blocks of rock outlined by northerly striking gouge slips and easterly striking shears that follow the trend of the shear zone are continually sloughing into the drifts and stopes.

The fracture zone and the dominant shears strike east-west. The quartz stringers are gash veins occupying short, straight tension breaks along which there has been little apparent displacement. Most of them strike east-northeasterly, which indicates that the north walls of the earlier formed east-west shears moved westerly with respect to the south walls. The premise that the Big Star shear follows a direction of maximum shearing stress has been used in the analysis of the structure of the producing area in the camp (pp. 43 to 45 and Fig. 3), and it was deduced from this that the direction of tension in the producing area is north 62 degrees east (p. 45). The diagonal quartz stringers in the Big Star shear have a strike that approximates this favourable direction of tension. They contain the gold mineralization for which the shear as a whole has been mined.

Alteration of the wallrock has been most pronounced along the east-northeasterly striking quartz stringers, and the quartz diorite has been bleached for widths from a fraction of an inch to several inches from each stringer. The wallrock of the gouge seams, strike north and east-west, has not been leached, but the gouge of these seams is a white clayey mass consisting mainly of residual quartz and fine white mica.

PROPERTIES ON BIBB CREEK.

Central Zeballos.* This property, on Bibb Creek, consists of A.B. (L. 1044), A.C. (L. 1045), A.D. (L. 1047), A.E. (L. 1046), Extension No. 5 (L. 1048), Extension No. 6 (L. 1049), Extension No. 7 (L. 1714), Extension No. 8 (L. 1715), Extension No. 9 (L. 1713), Extension No. 10 (L. 1712), Mon Fraction (L. 1878), and Bas Fraction (L. 1879) Crown-granted mineral claims. The assessed owner of the claims is Central Zeballos Gold Mines, Limited; company office, c/o Reno Gold Mines, Limited, 208 Yorkshire Building, Vancouver; O. C. Thompson, managing director; N. F. Brookes, manager.

Central Zeballos Gold Mines, Limited, at first a private company, was incorporated as a public company in April, 1938, and acquired the property the same year. In 1939 Reno Gold Mines, Limited, acquired 40 per cent. interest in the property in return for financing development work and took over operation of the property.

The main vein was discovered in September, 1937, by O. T. Bibb, who, with his associates, dug open-cuts and strippings above and west of the present upper adit (Figs. 29 and 30). In 1938 work was started on the two upper adits, and by the end of the year No. 1 adit had been driven over 300 feet, the crosscut in No. 2 completed, and over 400 feet of drift driven on that level.

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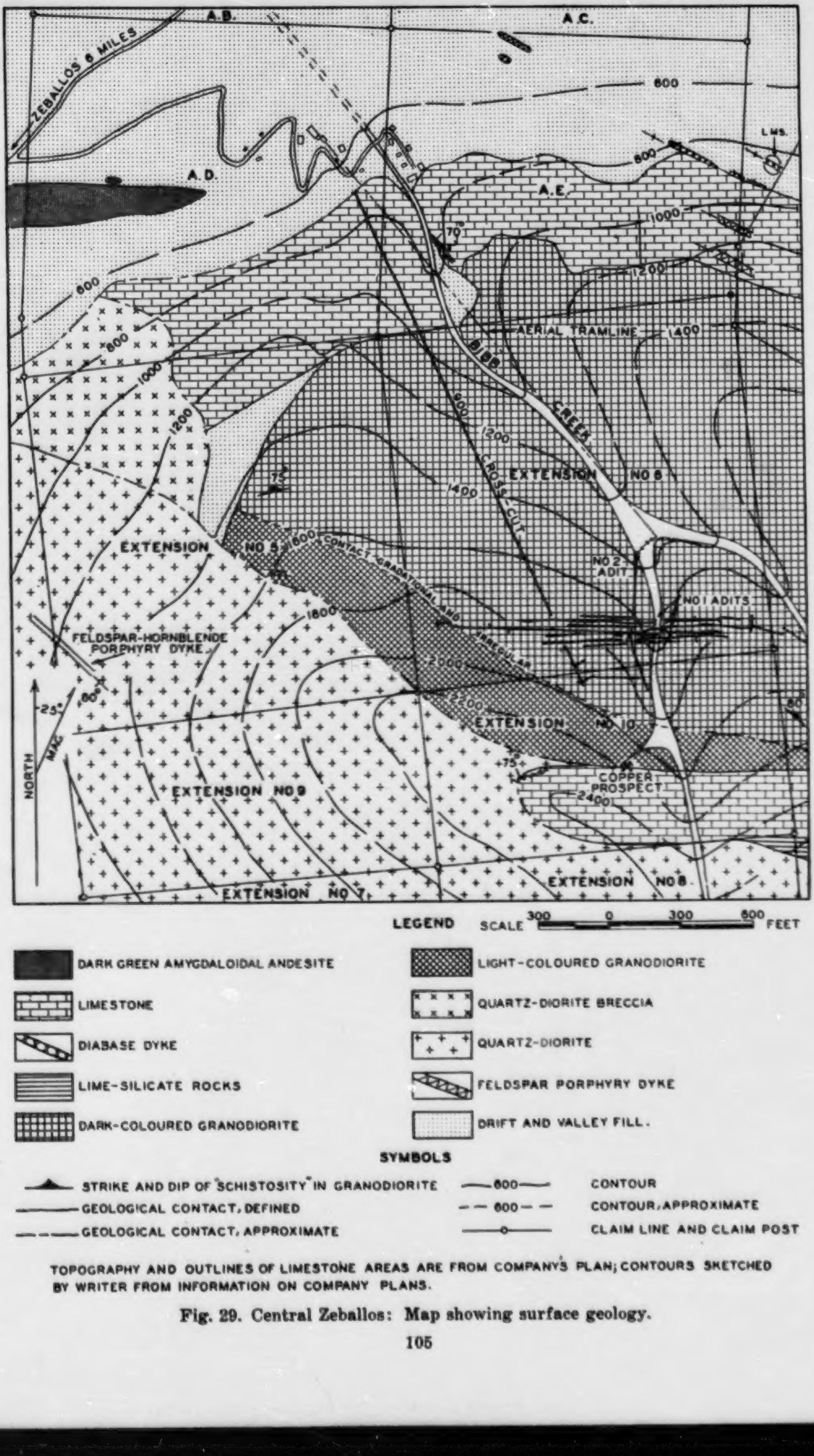
* *See* Figures 30 and 31 in pocket and Figures 29 and 32 in text.


A.B.
A.C.
ZEBALLOS 6 MILES
600
L.M.S.
A.D.
A.E.
70°
800
1000
1200
AERIAL TRAMLINE
1400
BIBB CREEK
CROSS-CUT
EXTENSION NO 6
75°
EXTENSION
NO 5
1600
CONTACT GRADATIONAL AND IRREGULAR
NO 2 ADIT
NO 1 ADITS
1800
FELDSPAR-HORNBLENDE PORPHYRY DYKE
2000
2200
EXTENSION NO 10
80°
75°
COPPER PROSPECT
2400
NORTH
MAG
25°
80°
EXTENSION NO 9
EXTENSION NO 7
EXTENSION NO 8
LEGEND
SCALE 300 0 300 600 FEET
DARK GREEN AMYGDALOIDAL ANDESITE
LIMESTONE
DIABASE DYKE
LIME-SILICATE ROCKS
DARK-COLOURED GRANODIORITE
LIGHT-COLOURED GRANODIORITE
QUARTZ-DIORITE BRECCIA
QUARTZ-DIORITE
FELDSPAR PORPHYRY DYKE
DRIFT AND VALLEY FILL.
SYMBOLS
STRIKE AND DIP OF "SCHISTOSITY" IN GRANODIORITE
GEOLOGICAL CONTACT, DEFINED
GEOLOGICAL CONTACT, APPROXIMATE
600 CONTOUR
600 CONTOUR, APPROXIMATE
CLAIM LINE AND CLAIM POST

TOPOGRAPHY AND OUTLINES OF LIMESTONE AREAS ARE FROM COMPANY'S PLAN; CONTOURS SKETCHED BY WRITER FROM INFORMATION ON COMPANY PLANS.

Fig. 29. Central Zeballos: Map showing surface geology.

In 1939–40 a winze was sunk 300 feet from No. 2 adit to the 500-foot level, and the 300- and 400-foot levels were opened from the winze. The long adit crosscut of No. 9 level, the mill adit, was started in 1940 and completed in 1941. By the middle of 1942 the raise had been driven from No. 9 level to the winze on the 500-foot level, and further drifting was done on that level.

Plate XV. Central Zeballos mill—view taken at time of shut-down during World War II.

An amalgation-flotation mill (Plate XV), with a daily capacity of 50 tons, was completed in January, 1940, and operated until the property was closed down in the autumn of 1942. The property was reopened early in 1946, and mining and milling were resumed, but because of the disappointing results of 225 feet of drifting on No. 6 level the mine was closed in the spring of 1947 and left under care of a watchman.

Pertinent data on production and operation are given in the following table. The production includes 45 tons of high-grade ore mined in 1938 and 1939 that was shipped to the smelter and yielded 185 ounces of gold and 118 ounces of silver. Twenty-five to thirty-five per cent. of the ore mined was sorted to waste before going through the mill. The quantity of concentrate was between 4 and 6 per cent. of the ore milled. About half of the gold and two-thirds of the silver were recovered in concentrates and the remainder in bullion.

Production and Operating Data, Central Zeballos Gold Mines, Limited.[1]

	Ore mined.	Ore treated.	Gold, Gross.[2]	Silver, Gross.[2, 3]	Costs per Ton milled.[4]		
					Development and Exploration.	Mining.	Milling.
	Tons.	Tons.	Oz.	Oz.	$	$	$
1938	31[5]	......	152	96	......	......	......
1939	14[5]	......	33	22	......	......	......
1939	500[6]	......	......	......	......	......	......
1940	19,811[7]	14,222	6,610	4,575	2.862	3.176	2.647
1941	20,119[7]	14,322	6,568	4,809	3.759	4.895	3.046
1942	7,022[3, 7]	5,100[8]	4,610[3]	3,083	9	9	9
1946[3]	3,843[7]	2,658	872	833	9	9	9
1947[3]	7,137[7]	5,353	1,627	1,200[10]	3.97	6.27	4.32
Weighted average[11]	......	......	......	......	3.42	4.39	3.08
Totals	58,450	41,655	20,472	14,618	......	......	......

[1] Information, except where noted, *from* Yearly Summary Reviews of the Gold Mining Industry in Canada, published by Dominion Bureau of Statistics, Ottawa.

[2] Total metal content in crude ore, bullion, and concentrates, as determined by settlement assay.

[3] Information from British Columbia Bureau of Economics and Statistics and British Columbia Department of Mines.

[4] Figures do not include taxes or head office, marketing, depreciation, and depletion charges.

[5] Crude ore shipped to smelter.

[6] Crude ore stored, metals recovered included in figures for year when milled.

[7] Mine-run ore, includes waste discarded on picking-belt.

[8] Estimated from ore mined.

[9] Information not available.

[10] Estimated from amount of gold produced, actual production figures not available.

[11] Weighted for variation in yearly tonnage.

The property is on the northeastern contact of the main area of quartz diorite (Fig. 2), and it is underlain by many different types of igneous and sedimentary rocks. The distribution of the principal rock types is shown in Figure 29. Dykes are too numerous to be shown.

A large outcrop of amygdaloidal andesite is found on the A.D. claim (L. 1047). Although much of the rock is badly sheared in an east-west direction, some of it is still massive enough to show unsheared and recognizable amygdules of finely granular quartz. The rock in this outcrop is not far from a large body of quartz diorite and has been partly recrystallized by the heat of the intrusion of quartz diorite. The amygdaloidal texture and similar mineralogy suggest that the rock in this outcrop is part of the body of andesite lava that outcrops in the bed of the Zeballos River and farther northerly to the edge of the map-sheet.

Limestone outcrops in two easterly trending areas northerly and southerly of the workings. The northern area, which is the more extensive of the two, is cut by the 900 crosscut (Fig. 30), in which there are two distinct, though intermingled, colour phases, one a dark grey and the other white. Analyses (*see* table, p. 18) proved that the grey limestone was a normal calcium limestone and the white a dolomitic limestone. This dolomitic limestone may have some economic importance, as has been indicated on pages 46 to 48 of this report.

The limestone on the property is massive and lacks recognizable bedding, as nearly all evidence of bedding was destroyed by recrystallization and irregular replacement of the grey or calcium limestone by the white or dolomitic limestone. However, a 2-foot band of dark-grey limestone 120 feet from the portal of the 900 crosscut and occasional bands of lime-silicate rock within the limestone elsewhere in the crosscut, all of which strike northwesterly and dip steeply southwestward, may indicate locally the strike and dip of the original beds of the limestone.

At several places along the contact with granodiorite, the limestone has been altered to garnet-diopside rock for a width ranging from 2 inches to 4 feet. At a few places, principally along the contact of the southern body of limestone with the granodiorite, the altered limestone includes small bodies of tan garnet, magnetite, and chalcopyrite.

A wedge-shaped area of laminated lime-silicate rocks, which strike easterly and dip vertically, is found between the limestone and the quartz diorite in the northeast corner of the Extension No. 8 claim (L. 1715). These rocks consist mainly of diopside, quartz, and plagioclase, and, in places, garnet and were probably calcareous tuffs before alteration.

Porphyritic granodiorite is the most widespread rock on the surface and in the underground workings. This granodiorite is part of a larger body, about 2,000 feet wide, that extends for about 4,000 feet east of the property (Fig. 2).

Two phases of granodiorite, a dark-coloured and a light-coloured, may be recognized on the surface and in the underground workings; the distribution of these two phases has been shown in Figures 29 to 32.

The dark-coloured granodiorite is a massive, dark-grey rock with conspicuous large crystals of feldspar, one-sixteenth to one-eighth of an inch in diameter, set in a fine-grained groundmass of recrystallized quartz, oligoclase, and orthoclase.

The light-coloured phase of the granodiorite is greyish-white and is slightly schistose in texture. Mineralogically it differs from the darker phase, having less biotite and more orthoclase relative to plagioclase in the groundmass; but it has the same large, partly altered grains of oligoclase. The light-coloured granodiorite intrudes the darker granodiorite, but the contacts are indefinite, and the distribution of two phases is difficult to determine.

The granodiorite, towards the centre of the Extension No. 5 claim (L. 1048), contains inclusions of andesitic volcanics from a few inches to 25 feet across, and it is possible to trace a textural and compositional gradation from volcanics into typical porphyritic granodiorite.

Quartz diorite is found in the southwestern corner of the property. This is the northeastern corner of the main area of quartz diorite in the Zeballos camp. It is the usual black and white, massive, medium-grained quartz diorite typical of that found elsewhere in the camp and does not show any sign of granulation or recrystallization such as is shown by the granodiorite.

Quartz-diorite breccia found near the western boundary of the property consists of angular fragments of green andesitic volcanic rock from an inch to several feet across, which are cemented by numerous criss-crossing dykes of quartz diorite.

Dykes and irregular tongues of quartz diorite in the granodiorite indicate that the quartz diorite intrudes the granodiorite. These dykes range in width from a few inches to 5 feet and extend as much as 100 feet from the quartz diorite into the adjacent granodiorite. In places they are so numerous that the resulting rock is granodiorite breccia sealed by quartz diorite.

Numerous types of dykes of several ages are found on the property. The oldest dykes are diabase. They strike northwesterly, dip vertically, and are found in the north band of limestone. In the 900 crosscut, five dykes ranging in thickness from 10 inches to 2 feet cut the limestone.

Diabase dykes are not found in any of the main intrusive bodies, and those in the limestone nearest the quartz diorite have been recrystallized by the heat of the intrusion of the quartz diorite.

The diabase dykes towards the east boundary of the A.E. claim are relatively unaltered, and are massive, dark greyish-green, fine-grained rock with occasional feldspar phenocrysts an eighth of an inch long. Under the microscope the rock is seen to consist mainly of laths of andesine (An_{35}), 0.1 by 0.5 millimetre, with abundant patches of smaller shreds of actinolite or, in some sections, of green hornblende and occasional grains of quartz. The dykes have a good diabasic texture and show no sign of recrystallization. Those in the 900 crosscut are much nearer the quartz diorite than those to the east and have been considerably altered. They are massive, dark brown, fine grained, and have a definite hornfels texture characteristic of recrystallization by heat.

Light greyish-green dykes are abundant in the main drifts. They are fine grained and porphyritic and range in width from a few inches to 25 feet. They have been referred to in the past as aplites, but microscopic studies show that they are porphyritic dacite (quartz andesite) dykes. They cut both the granodiorite and the quartz diorite.

As seen under the microscope, the dacite dykes consist of large plagioclase phenocrysts in a groundmass of smaller plagioclase laths and of quartz. The feldspar of the phenocrysts and groundmass is oligoclase. The grains of feldspar are strongly altered in large patches to carbonate and sericite, more so in the phenocrysts than in the groundmass. The alteration of the feldspar to carbonate and sericite is very marked. Carbonatization preceded sericitization. Whole phenocrysts have altered to carbonate, and the carbonate partly replaced by a closely packed aggregate of sericite. Silicification is only slight in the narrower finer-grained dykes. The femic minerals have been completely altered to scattered sheaves of light-green chlorite. Many of the plagioclase crystals contain patches of chlorite. Only a little epidote was seen in thin sections from these dykes.

The dacite dykes that are less than 2 feet wide have a fine-grained groundmass consisting of oriented, small plagioclase laths in which oligoclase-andesine feldspar phenocrysts, similar in size to those in the larger dykes, stand out prominently. The flowage of the groundmass laths is not always parallel to the walls of the dyke; it may be perpendicular to the walls, or may be concentric, or may flow around the plagioclase phenocrysts. These varied directions of flowage indicate a turbulence during emplacement of the dyke and crystallization of the groundmass. The fine grain of the narrower dykes indicates that the dykes as a whole were injected into the granodiorite after the granodiorite had cooled.

The texture of all the dacite dykes is entirely primary. There has been neither microbrecciation nor recrystallization such as characterizes the enclosing granodiorite.

Light-grey feldspar-porphyry dykes outcrop at several places on the property. They range in width from a few feet to 50 feet and show conspicuous feldspars, one-eighth to one-quarter of an inch long, in a medium-grained groundmass. These dykes consist of andesine (plagioclase) phenocrysts, one-sixteenth of an inch long, set in a fine-grained base consisting of slightly less calcic plagioclase, quartz, and a small amount of actinolite and biotite. In a few dykes there seems to be enough quartz to make the rock quartz diorite in composition.

Swarms of narrow, light-coloured, non-porphyritic dykes, ranging in width from one-eighth of an inch to 4 inches, cut the quartz diorite in many places, and in some places they are so abundant that the rock is a quartz diorite breccia. Although the dykes are light coloured and medium grained and have the appearance of aplites, they lack both the texture and composition of aplites. They possess a typical granitic texture, rather than the sugary texture typical of aplites, and have the mineralogical composition of orthoclase-rich granodiorite or quartz monzonite.

A lamprophyre dyke, 6 feet wide, cuts the granodiorite in No. 1 adit west. This dyke consists of a fine-grained aggregate of andesine, green hornblende, brown biotite, and a little quartz. All the minerals are fresh, and most show the well-developed crystal boundaries characteristic of the texture of lamprophyres.

The vein (Figs. 31 and 32) is known for a strike-length of about 1,500 feet and to a depth from the outcrop of about 1,100 feet. It has been found on all the levels but has been stoped only down to the No. 5 level; the area within which it has been stoped is about 900 feet long by 670 feet deep. No evidence of the vein is seen easterly

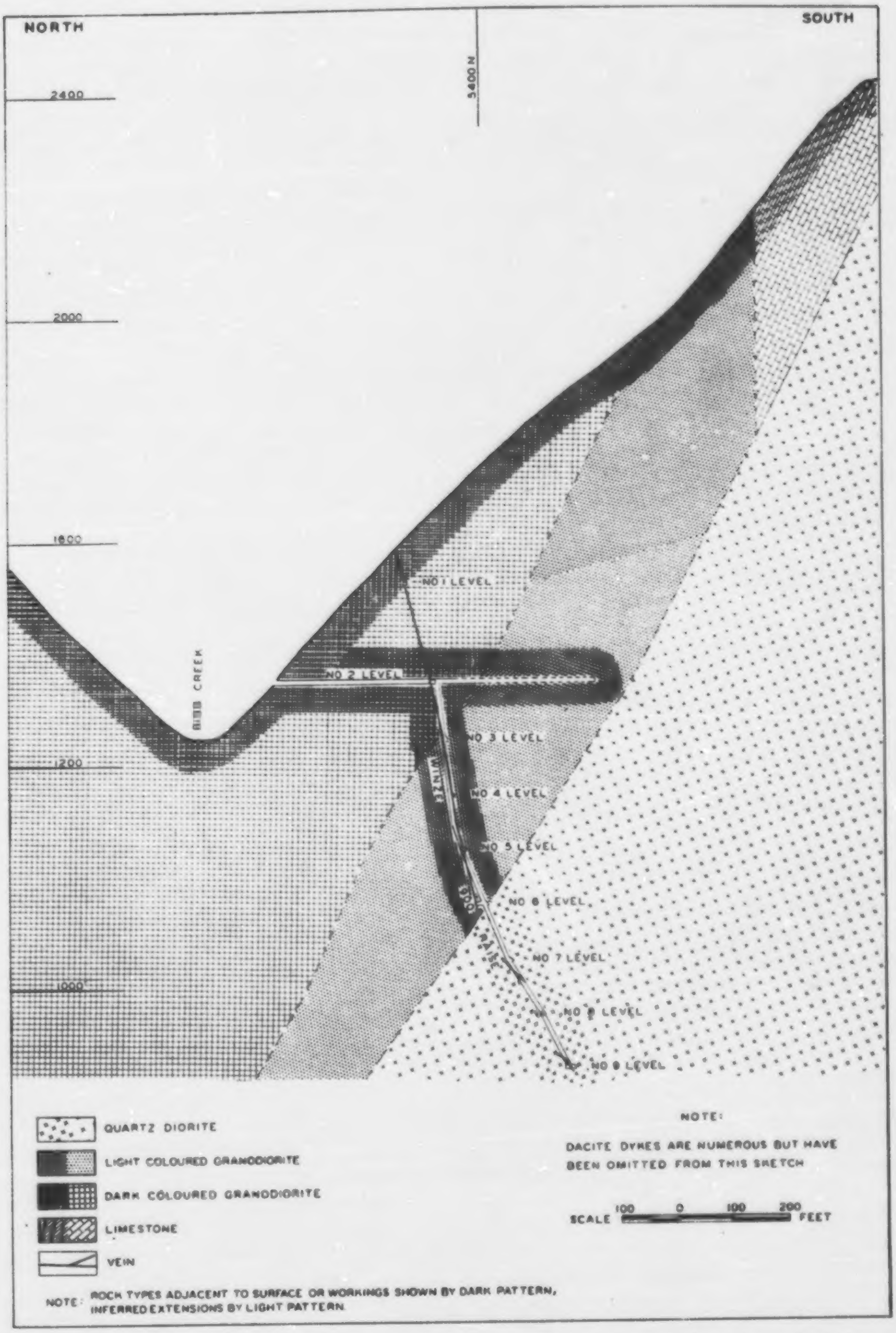

NORTH
SOUTH
3400 N
2400
2000
1600
1200
1000
BIBB CREEK
NO 1 LEVEL
NO 2 LEVEL
NO 3 LEVEL
NO 4 LEVEL
NO 5 LEVEL
NO 6 LEVEL
NO 7 LEVEL
NO 8 LEVEL
NO 9 LEVEL
WINZE
1600
RAISE
QUARTZ DIORITE
LIGHT COLOURED GRANODIORITE
DARK COLOURED GRANODIORITE
LIMESTONE
VEIN
NOTE: ROCK TYPES ADJACENT TO SURFACE OR WORKINGS SHOWN BY DARK PATTERN, INFERRED EXTENSIONS BY LIGHT PATTERN.
NOTE:
DACITE DYKES ARE NUMEROUS BUT HAVE BEEN OMITTED FROM THIS SKETCH
SCALE
100
0
100
200
FEET

Fig. 32. Central Zeballos: Cross-section of vein, showing geology, taken through raise.

from the workings in the granodiorite or westerly from the workings in the quartz diorite. The only evidence of the vein or vein shear to the west is a marked depression, 15 feet wide and 30 feet long, along the projected strike of the vein and about 100 feet west of the granodiorite-quartz diorite contact. The vein fracture is less continuous on the lower levels than on the upper levels. Down to No. 5 level it is moderately continuous over the length of the drift, but below this, as on No. 9 level, the vein is less continuous, and the quartz follows short fractures that branch at small angles from each other, although in general they follow the strike of the vein as found in the upper levels. This apparent weakening of the vein fracture is roughly coincident with the passage from granodiorite into the underlying quartz diorite at about No. 6 level (a shaft station only).

The vein, except locally, is a well-defined shear, strike east to west and dip 75 to 80 degrees southward, and contains discontinuous quartz. Where well defined, the shear ranges in width from 3 to 18 inches and, apart from quartz, contains highly sheared rock and a few inches of gouge. The quartz ranges in width from 1 to 10 inches and in the ore sections from 8 to 10 inches.

The continuity of the vein shear is interrupted in places by diagonal joints that strike northeasterly and dip steeply northwestward. Where the main shear intersects a well-developed set of diagonal joints, it weakens, and the main break, which contains the vein quartz, follows the northeastern diagonals for 10 to 30 feet, then changes in strike and follows the original easterly trend of the break. Where the diagonal joints are weak, or where only one or two are developed, the vein shear and quartz continue their easterly direction, but quartz, 1 to 2 inches wide, may extend along the diagonals for 5 to 20 feet. Because of this tendency to follow northeasterly diagonal joints, the average strike of the vein, as shown by the trend of the drifts, is a few degrees north of east. There does not seem to be any relation between the frequency of these diagonals and the presence of the ore. Ore is found both in straight sections of the shear not offset by diagonals and in sections of the vein offset by numerous diagonals.

Occasionally the main shear, which contains quartz, splits into two breaks, 4 feet apart, that continue for 20 to 50 feet and then converge again. Sheeting is not common, but, where found, consists of joints spaced 2 inches apart and parallel to the main vein shear.

Rounded granules of vein quartz are occasionally found in the shear, which indicates that some shearing took place after the formation of the vein. However, the later shearing has not been extensive enough to slice the vein by diagonal faulting or to repeat the width of the vein by parallel faulting.

The best vein matter consists of 8 to 10 inches of quartz and roughly banded sulphides, which in places possess a comb texture formed by well-shaped crystals of quartz projecting inward from the walls (Plate X).

In non-commercial sections, the quartz usually ranges in width from 1 to 3 inches, is sometimes finely ribboned, and often lacks sulphides. Long sections of the vein shear consist only of sheared rock and gouge and lack quartz.

The proportions of drift in ore and in non-ore are apparent in the longitudinal section (Fig. 31). It is understood that additional sections in Nos. 3, 4, and 5 drifts were stoped in 1946 and prior to cessation of operations early in 1947.

The scarcity of suitable crosscutting contacts and dykes makes it difficult to measure the displacement along the vein shear. However, it is probable that the displacement has been small, as the northern continuation of a lamprophyre dyke in No. 1 level west has been offset only about 5 feet.

Alteration of the wallrock extends for only a few inches from the vein shear. In such places the normal granodiorite has been bleached from a black rock to a grey rock with silvery mica, and, similarly, the quartz diorite has altered to a white crumbly rock consisting mostly of sericite or kaolin and quartz.

Although the main vein shear is the only strong break on the property, a parallel, easterly striking shear, about 2 feet wide, is found in a 3-foot band of garnet rock between the quartz diorite and the north contact of the south band of limestone (Fig. 29).

The only break with a strike diagonal to that of the other breaks on the property is in the centre of the Extension No. 5 claim (L. 1048) (Fig. 29), where a northwesterly striking shear zone, 2 feet wide, follows the contact between quartz diorite and granodiorite.

Structural Control of Ore Deposition.—At the Central Zeballos mine the vein follows a shear, strike east-west and dip 75 to 80 degrees southward, in granodiorite and the underlying quartz diorite.

The quartz diorite appears to have been intruded and to have crystallized as an ordinary magma, but the granodiorite appears to have been formed earlier by metasomatic replacement of older rocks, mainly volcanics, that formerly lay between the two bands of limestone north and south of the granodiorite. Early deformation resulted in an east-west schistosity in the volcanics parallel to the limestone bands, a schistosity that still remains in the few unreplaced patches of volcanics and is also reflected in part of the granodiorite.

The schistose and probably slightly sheared condition of the volcanics would serve to localize the magmatic solutions responsible for their metasomatic replacement. Later deformation, localized along former lines of weakness, would follow the east-west body of granodiorite, but, as the granodiorite was a more brittle rock than the former volcanics, the deformation would find relief along a single strong break manifested in the shear now followed by the main vein on the property.

Nearly all the ore has been found in the granodiorite, and relatively little in the underlying quartz diorite. A drift 350 feet westerly from the bottom of the 900 raise and shorter drifts farther up the raise, all in quartz diorite, found little ore.

The oreshoots are above a bulge (Fig. 31) along the upper surface of the quartz diorite between the western end of No. 4 level and No. 6 level station. This bulge is reflected in a corresponding bulge of the contact between light- and dark-coloured granodiorite, a feature that may be seen in section between the western end of No. 3 level and the eastern end of No. 5 level. Extensive drifting was done on No. 2 adit easterly and westerly from the region of the bend, but failed to find much ore. It is possible that the bulge in the quartz diorite and overlying granodiorite served to funnel or localize mineralizing solutions from a source deep within the quartz diorite or deep within the magmatic reservoir, from which the various related magmatic products originated. Other bulges may exist elsewhere along the contact and, if intersected by the vein shear, may have served to localize ore.

In the upper workings the vein shear intersects a zone 200 feet wide of dacite porphyry dykes that strike north 70 degrees east and dip 75 degrees south (Fig. 30). The dykes are not found along the drifts on the lower levels because the intersection of the vein shear with the zone of dykes, which pitch steeply eastward from the upper workings, is beyond the east faces of the lower workings. As this zone of dacite dykes is not found with the ore in the lower levels, they do not appear to have had a localizing influence on the ore.

Copper Showings.—A showing of chalcopyrite is seen in the bed and up the sides of a rocky canyon 700 feet above and approximately 600 feet southerly from the upper adits (Fig. 29).

Disseminated chalcopyrite and pyrrhotite are found throughout a dense, siliceous green rock that consists principally of diopside; the mineralization responsible for the formation of these sulphides and of the lime-silicate mineral diopside represents high-temperature replacement of limy sediments. The zone of maximum sulphide deposition is 20 feet wide, strikes east, and appears to dip 75 degrees northward.

PROPERTIES ON NOMASH RIVER.

Homeward Mines, Limited. This company, 703 Royal Trust Building, Victoria (J. S. Oswald, secretary-treasurer), owns the Crown grants H and J No. 1 (L. 1792), H and J No. 2 (L. 1793), H and J No. 3 (L. 1794), H and J No. 4 (L. 1795), H and J No. 5 (L. 1996), H and J No. 6 (L. 1796), H and J No. 7 (L. 1997), H and J No. 8 (L. 1998), and H and J No. 9 (L. 1797), on the northwest side of Curly Creek, a northeasterly flowing tributary of the Nomash River.

These claims were staked in the summer of 1937 by H. E. Smith and constituted the property known at the time as the Golden Horn. In 1938 surface work but no underground work was done by Pioneer Gold Mines, Limited.

The present company, at first a syndicate, acquired the property in 1939, drove the two main adits, and built an amalgamation-flotation mill with a daily capacity of 50 tons. The mill operated from June, 1941, to February, 1942, when the mine was closed. During the period of operation 3,652 tons of ore was mined, approximately 1,400 tons milled, and 1,491 ounces of gold and 3,500 ounces of silver, gross,[*] produced. About a quarter of the gold and about three-quarters of the silver were recovered in concentrates and the remainder in bullion.

The showings are within the quartz diorite batholith (Fig. 2), and the only rocks other than quartz diorite are a few andesite dykes, from 6 inches to 2 feet wide, strike north 70 degrees west and dip vertical.

Four veins, Nos. 1 to 4, have been found on the property, but all the underground work and mining has been done on No. 1. The other three veins, up the mountainside westerly from the adits, were found when the property was first prospected and opened up by stripping. They are reported to lie less than 600 feet north of No. 1 vein and to consist of vertical, east-west striking quartz veins, from 0 to a few inches wide, that follow narrow shears in the quartz diorite. Subsequent to the writer's last visit to the property in 1945, another vein was discovered when the claims were being surveyed for Crown grant in 1946. Known as the Forrest vein, it is reported to be near the southern boundary of the H and J No. 4 claim (L. 1795), to strike east-west, to be 3 inches wide, and to assay well in gold.

No. 1 vein, strike east-west and dip 85 degrees northward, has been followed by two adits for 850 feet; several sections of ore have been stoped between the adits (Fig. 33). The vein is reported to have been traced westerly up the mountainside by open-cuts and strippings for about 2,600 feet from the portal of the lower adit and easterly down the slope by other surface workings, now all caved, and by an outcrop in Curly Creek, 1,000 feet from the portal of the lower adit, making a total strike distance of about 3,600 feet and a vertical distance of about 2,000 feet.

As seen in the adits, No. 1 vein ranges in width from 0 to 12 inches, a 3-inch width being common. The vein matter consists of quartz and abundant sulphides, principally pyrite and fine-grained arsenopyrite with some sphalerite and galena and occasionally free gold. Due to post-vein faulting, the sulphides frequently are found as pasty masses of pulverized minerals. Patches of coarsely cleaved calcite are occasionally seen in the vein.

The vein follows a strong crush and shear zone, up to 30 inches wide, but usually about 10 inches wide, which contains, apart from the quartz, sheared and crushed quartz diorite that has been bleached to a white mass. In places, as in the back of No. 2 stope in No. 1 adit, the shear and vein will follow one wall of a dyke for a short distance, cross the dyke, and follow the other wall a short distance and then leave it.

A few diagonal quartz veins with frozen walls were seen. In places the main vein crosses from one wall of the shear to the other along a diagonal, then continues along the original strike. The quartz in the diagonals is usually wider than in the main vein near by. The diagonals strike about north 63 degrees east and dip 60 degrees north-

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[*] Total metal content in bullion and concentrates, as determined by settlement assay.

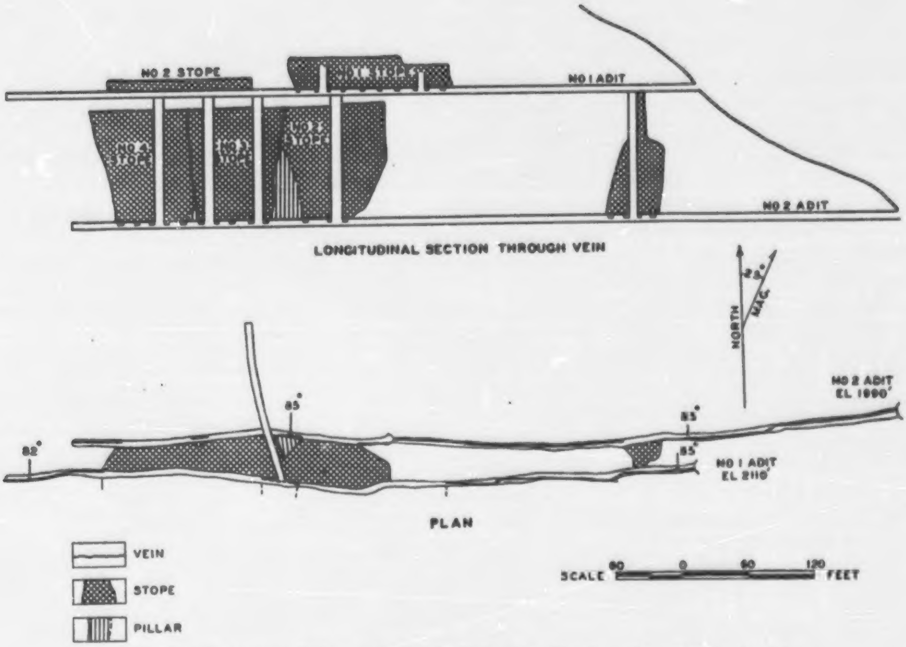

Fig. 33. Homeward: Plan of adits and longitudinal section through vein.

westward. They, therefore, indicate that the north side of the main shear moved west, in accordance with the direction of movement on other east-west breaks in the area (p. 45).

Numerous samples taken along the drifts indicate that sections of commercial ore alternate with sections of sub-commercial ore. In January, 1942, mill-heads were reported to range from 0.72 to 0.84 ounce of gold per ton, and the average mill-heads from October, 1941, to February, 1942, are reported to have been about 0.58 ounce per ton.

Monitor. The Monitor group extends southeasterly from the Homeward property across the Nomash River and includes the Monitor Nos. 1 to 3, 5 to 8, and 11 to 13, staked in 1945 and held by location by John Creagh. Most of the claims cover ground originally staked under the same group name in 1937.

The workings consist of three adits, all within the main area of quartz diorite (Fig. 2).

The longest adit, elevation 1,260 feet, is reached by a trail that leaves the Homeward caterpillar-road about 2,000 feet north of the Homeward camp. This adit has been driven south 23 degrees west for 128 feet without crosscutting any vein. The adit is reported to have been driven with the thought of intersecting the downward extension of a "mineral zone" in a showing reported to be about 200 feet above. The writer was unable to find this showing.

Two shorter adits between elevations of 1,500 and 1,520 feet are reached by a foot-trail that leads southerly from the Homeward camp (Fig. 2).

The adit at 1,500 feet elevation has been driven north 75 degrees west for 40 feet along two quartz-pyrite stringers that range in width from a knife-edge to 2 inches within shear zones 6 inches wide. Ten feet from the portal the south vein, strike east-west and dip vertical, diverges from the north vein and crosses the break into the south wall of the working 20 feet from the portal. At 15 feet from the portal the adit bends slightly to the north, and the north vein, strike north 80 degrees west and dip 80 degrees northward, is found along the south wall from here to the face.

The adit at 1,520 feet elevation is 25 feet westerly from the adit at 1,500 feet and has been driven for 12 feet along a vein, strike north 80 degrees west and dip vertical. The vein in this adit is similar to that in the 1,500-foot adit.

Forty feet above the 1,520-foot adit a caved open-cut apparently picked up the western continuation of the vein.

All the work on the property was done by the owner, John Creagh, except the first 65 feet of the lower crosscut, which was done by Conrad Wolfe, who had an option on the property at the time.

PROPERTIES ON NORTH FORK OF THE ZEBALLOS RIVER.

King Midas. This property, on the north fork of the Zeballos River, consists of the following Crown-granted mineral claims: Big Ben No. 1 (L. 1675), Big Ben No. 2 (L. 1676), Big Ben No. 3 (L. 1677), and Big Ben No. 4 (L. 1678), located in 1932; Big Ben Fraction (L. 1674), located in 1935; Yauco No. 2 (L. 1671), Yauco No. 4 (L. 1665), Yauco No. 5 (L. 1666), Yauco No. 6 (L. 1668), and Yauco No. 7 (L. 1679), located in 1931; Yauco No. 12 (L. 1667) and Yauco Fraction (L. 1673), located in 1935; Goldrock No. 1 (L. 1670) and Goldrock No. 3 (L. 1669), located in 1933; and Goldrock Fraction (L. 1672), located in 1935, all brought to Crown grant between 1936 and 1939 and owned by the King Midas Mining Company, Limited, c/o J. Link, Regent Hotel, Vancouver.

The property was staked in 1926 by T. H. Marks. Marks Gold and Copper Mines, Limited, incorporated in 1928, was dissolved in November, 1932, after doing surface work on the quartz veins and on large low-grade bodies of disseminated sulphides. During the period from 1932 to 1933 Mr. Marks, backed by Vancouver interests, started No. 1 adit by crosscutting 60 feet to the vein and began drifting southward. In July, 1933, King Midas Mining Company, Limited, was incorporated and, under the supervision of J. S. Rear, continued work on the property. This company put a cableway across the north fork near its junction with the main Zeballos River, sunk a winze in No. 1 adit, continued the drift 100 feet south, and started No. 2 adit 140 feet south of No. 1. In 1934 the north drift was driven in No. 1 adit. Little work was done on the property from 1934 until the period 1938–39, when some surface work was done on the river showings during low water; work was stopped in September, 1939, since when no work appears to have been done. The King Midas Mining Company was dissolved in November, 1943. One ton of ore, containing 5 ounces of gold, 1 ounce of silver, and 23 pounds of copper, is reported to have been produced in 1940.

The King Midas cabin is reached from the end of the Zeballos road, below the Central Zeballos mine, by 1¼ miles of pack-horse trail that crosses the Nomash River at a ford 1,000 feet upstream from its junction with the north fork of the Zeballos River. From the ford the trail proceeds northerly up the east bank of the north fork to the cabin.

The property is underlain by andesite and limestone, which are cut by feldspar porphyry dykes. The faulted contact between the andesite and limestone follows the bed of the north fork of the Zeballos River (*see* Fig. 2).

Several narrow gold-bearing quartz veins and chalcopyrite-pyrrhotite replacement bodies in limestone are found on the property. Work has been done on the three most promising veins, No. 1 vein on the west side of the north fork of the Zeballos River, the Trail, and the Glory-hole or Contact veins on the east side of the river.

The principal quartz vein, No. 1 vein, is found south of Fault Creek on the west bank of the river, where it has been developed by two adits. No work has been done on the vein and adits since 1938, when Bancroft visited the property and described the No. 1 vein and the adits as follows (Bancroft, 1940, pp. 31, 32):—

No. 1 vein, as crosscut by No. 1 adit and exposed by surface cuts, is typical of the narrow fissure type of deposit. The normal vein is a few inches wide and splits locally into parallel stringers, but has been traced along the steep slope south of Fault Creek for 260 feet. It is a quartz vein with considerable zinc blende, arsenopyrite, pyrite, chalcopyrite, and a little galena. It carries high gold values, apparently associated with the zinc blende. A vein parallel to it has been found 800 feet up Fault Creek. These veins strike parallel to the north fork fault, or north 6 degrees west, and are vertical or dip steeply east.

No. 1 adit is about 450 feet south of Fault Creek on the west side of the north fork and 10 feet above the river. This adit has been driven from a 20-foot rock cut 60 feet to cut No. 1 vein, 90 feet below the best exposed part of the vein. The crosscut was extended beyond the vein for 40 feet. A winze is sunk 16 feet on the vein where crossed by the adit. At the winze, the vein consists of parallel stringers; there are five distinct veins at the winze, the widest is 5 inches on the floor of the adit and the others average about 3 inches in width. The veins are from 12 to 15 inches apart, the country rock between them is seamed with tiny veinlets, and the wall-rock is impregnated with sulphides. The wall-rock is a silicified volcanic rock, probably andesite. The principal minerals in the veins are sphalerite, arsenopyrite, pyrrhotite, and pyrite in a quartz gangue. Some of the veins are frozen to their walls; others break clean and have no gouge. Assays from the winze are high in gold.

Drifts have been made on No. 1 vein from the winze south 62 feet and north 125 feet. The east 5-inch vein continues strong in the north drift for some distance when it turns into the west wall. The south drift is in ore for about 30 feet when it runs into broken ground.

No. 2 adit is parallel to No. 1 and 140 feet to the south; its length is 155 feet. It cuts small quartz stringers between 116 and 130 feet from the portal. At the face it shows strong jointing, which strikes north 82 degrees east and dips north 80 degrees, in grey feldspar porphyry.

On the north side of Fault Creek, 150 feet upstream from the river, an adit has been driven north for 23 feet along a lenticular calcite vein, a knife-edge to 2 inches wide, in andesite.

About 50 feet up the steep, north bank of the creek, strippings and open-cuts about 100 feet long have been made on a vein or silicified shear zone known as the Lynch vein, strike northerly and dip vertical. The vein, 6 to 10 inches wide, consists of replacement quartz containing abundant sphalerite, chalcopyrite, pyrrhotite, and pyrite. A sample of oxidized vein matter from this showing taken by the writer in 1938 assayed: Gold, 1.84 ounces per ton; silver, 0.2 ounce per ton; copper, 0.5 per cent.; zinc, 2.8 per cent.; arsenic, *nil*.

On the rocky south bank of Fault Creek, about 200 feet upstream from its mouth, a shear, 3 to 6 inches wide, strike north 20 degrees east and dip 45 degrees southeastward, contains a narrow ribbon of banded quartz mineralized with abundant arsenopyrite and smaller amounts of chalcopyrite, pyrrhotite, and sphalerite. A sample of this vein matter taken by the writer in 1938 assayed: Gold, 0.6 ounce per ton; silver, 0.1 ounce per ton; copper, trace; arsenic, 3.1 per cent.

The Trail and Contact gold-bearing veins are on the east side of the river, several hundreds of feet upstream from the King Midas cabin. The following description follows closely an earlier report by the writer.

The first showing on the Trail vein is approximately 2,300 feet northward from the cabin along the trail that follows the east side of the north fork. The showing consists of a tight vertical shear, 8 inches wide, that strikes north 10 degrees east. This shear contains a frozen quartz vein that ranges in thickness from 5 to 8 inches and contains pyrite, chalcopyrite, and pyrrhotite. The vein, as such, is exposed by one trench 50 feet long, and 50 feet farther north by another shorter combined stripping and trench. Apparently the same vein is exposed at a point about 250 feet farther northward along the trail and on the south side of a creek flowing westward. The creek bed and a small stripping on its south bank expose a 15-foot length of vein. An adit, 30 feet long, has been driven on the vein. It has been reportedly traced along its strike for 1,800 feet. The vein strikes north 12 degrees east, dips 65 degrees east, and consists of two tight lenses of quartz along the strike that range in thickness from 1 to 7 inches. However, the quartz vein matter dies out northward along the strike of the shear. The quartz contains pyrite, chalcopyrite, and abundant pyrrhotite.

A sample of the vein matter assayed: Gold, trace; silver, trace; copper, 0.8 per cent.; zinc, *nil*.

The Glory-hole or Contact vein is about 150 feet westward below a point in the trail half a mile northward from the cabin where it follows the rim of a waterfall on a creek that flows westward into the north fork about 1,200 feet upstream from Fault Creek. The rim of the waterfall is about 100 feet eastward from the river and 80 feet above it. The vein is reported to have been traced along its strike for 850 feet. The quartz vein, strike north 5 degrees west and dip 75 degrees northeastward, is 1 to 5 inches thick and follows a fissure 5 to 10 inches wide. The quartz contains pyrite, chalcopyrite, and abundant pyrrhotite. A sample of typical vein matter taken by the writer in 1938 assayed: Gold, 0.2 ounce per ton; silver, trace. The rock formations consist of white crystalline limestone on the footwall side and of andesitic greenstone on the hangingwall side.

No work has been done on the chalcopyrite-pyrrhotite replacement deposits in limestone since they were examined in 1932 by Gunning, who described them (Gunning, 1932, p. 42A) as follows:—

> The copper mineralization on the property is on the west side of the north fork and north of Fault Creek. For about 2,500 feet north of this creek andesitic flows and fragmentals are intruded by many grey to green, feldspar porphyry dykes and are considerably fractured and locally sheared. They have been extensively chloritized and mineralized, either very irregularly or along bedding or shear planes, by mixtures of quartz, epidote, pyrite, chalcopyrite, and pyrrhotite. Development has been concentrated in an area about 200 feet long, north and south, and from 100 to 125 feet wide, west of the river bed, some 800 feet north of Fault Creek. Here several open-cuts have been made on the steep hillside and they reveal some fine copper ore. Exposures between the scattered cuts are poor, however, so that it is difficult to form an accurate picture of the occurrence. But it seemed to the writer that the principal mineralization trends about parallel to the north fork and that well-mineralized material forms from 15 to 20 per cent. of the total width of about 125 feet partly developed by cuts, the remainder being altered and pyritic volcanic. The volcanic rocks near the upper showings appear to strike about north 15 degrees west (nearly parallel to the river) and dip at 45 degrees or less to the west. Both north and south of this principal section, the mineralization is less promising. To the north, large bodies of quartz are exposed along the bank of the stream, but they generally contain only a meagre amount of chalcopyrite and pyrite. To the south, there is much less quartz, and what little copper there is occurs in chloritic volcanics with pyrite. In the Quatsino limestone on the east side of the river, there are many pockets and small, irregular bodies of pyrrhotite with some chalcopyrite, but nothing sufficiently persistent to encourage development. One or two of the porphyry dykes along the creek bed are themselves mineralized along joints and cracks with narrow seams of quartz, pyrrhotite, and chalcopyrite.
>
> South of Fault Creek, there are one or two showings of similar, irregular copper mineralization in the volcanics, but none has as yet received any extensive development.
>
> On the whole, it seems that there is an extensive, low-grade copper mineralization on the claims which, under favourable market conditions, would merit some further development.

North Fork Exploration.

This property, which is situated on the east side of the north fork of the Zeballos River three-quarters of a mile by foot-trail north from the King Midas and beyond the edge of the map-area, consisted, in 1938, of a large number of claims, held by location, adjoining the King Midas claims on the north. No production has been recorded.

In 1937 and 1938 what is apparently the northern extension of the Trail vein from the King Midas was traced by surface workings and two adits for a strike-length of about 320 feet, but no work has been done on the showings since then.

At elevation 755 feet and 4,500 feet northerly along the trail from the King Midas cabin, an adit has been driven north 65 degrees east for 10 feet, thence north 10 degrees east along the vein for 39 feet to the face. The vein, 1 to 5 inches wide, follows a strong shear zone, 6 to 10 inches wide. The quartz is heavily mineralized with arsenopyrite and sphalerite, and with smaller amounts of chalcopyrite and pyrrhotite. A sample across 4 inches of such material 14 feet from the face assayed: Gold, 6.34 ounces per ton; silver, 0.5 ounce per ton.

About 100 feet farther north and at elevation 780 feet, a crosscut has been driven easterly across the same vein, here 5 inches wide and consisting of quartz and abundant sulphides.

Northerly from this crosscut the vein has been traced for about 250 feet by a series of open-cuts and pits. Some of these cut a definite vein shear, but, where cut, the shear lacks quartz vein matter. Some of the cuts did not reach bedrock. At the northern end of the surface work the vein shear is 1 to 2 inches wide but contains no vein matter.

A short distance below the main drift, elevation 755 feet, another adit, locally referred to as the " Big Onion " crosscut, was started at elevation 635 feet to intersect the vein. This had been driven north 57 degrees east for 67 feet through overburden but at that distance had not reached bedrock.

The rock in all these showings is dark-green amygdaloidal andesite, containing amygdules, one-eighth to three-quarters of an inch in diameter, of quartz, epidote, and calcite.

Goldspring. This property, on Fault Creek, was first staked in 1937 by Sam Knutsen and has been staked several times since then under different names. Nearly all the work on the property was done in 1938 and 1939 by Zeballos Goldspring Mines, Limited, 1016 Hall Building, Vancouver, which was incorporated in 1938, and whose charter was cancelled in 1942. No work has been done on the property since 1939. No production has been reported.

The camp and the workings are on the south bank of Fault Creek. The workings, which consist of two adits (Fig. 34) and several strippings, are between elevations of 1,540 and 1,760 feet.

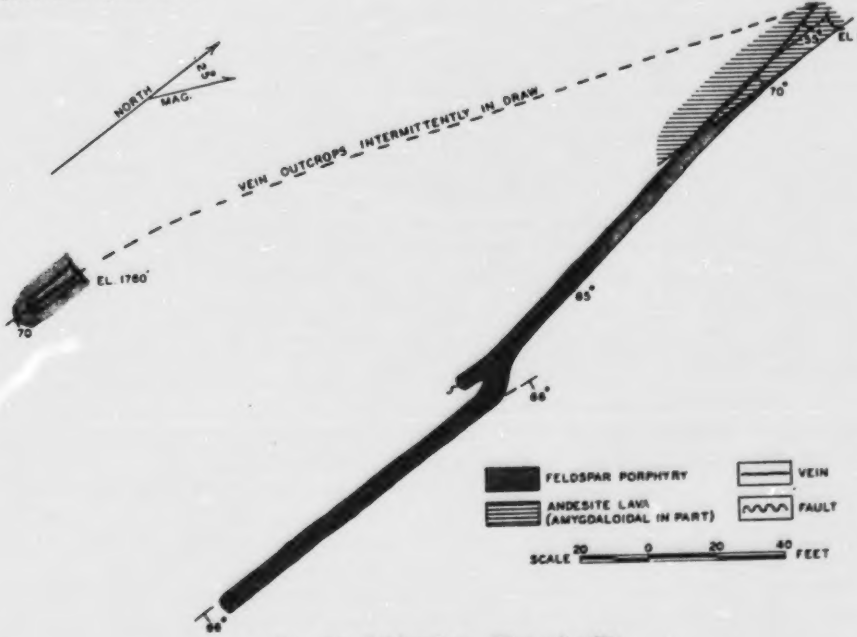

Fig. 34. Goldspring: Plan of adits.

The camp, elevation 1,220 feet, may be reached by a steep switchback foot-trail about 3,000 feet long that crosses the north fork of the Zeballos River at a cable crossing, elevation 440 feet, opposite the King Midas camp and follows up the south side of Fault Creek. A foot-trail connects the camp with the workings.

The showings consist of two northerly striking gold-bearing quartz veins in andesite lava. The andesite is dark green, massive, and consists of both porphyritic and amygdaloidal flows; the latter strike north 35 *degrees west and dip 60 degrees* southwestward. The andesite is cut by northerly striking feldspar porphyry dykes up to 20 feet wide.

The eastern vein has been followed by the two adits (Fig. 34) and is exposed at several places between the adits and below the lower adit in the bed of a watercourse tributary to Fault Creek. This vein, strike north 5 degrees west and dip 55 to 70 degrees eastward, is 1 to 8 inches thick and follows a rusty shear zone 5 to 12 inches wide. The quartz contains abundant pyrite, occasional patches of chalcopyrite, and minor amounts of sphalerite and galena.

In the lower adit (Fig. 34) the vein is in andesite for only 60 feet from the portal, and then it bends to follow a southerly striking feldspar porphyry dyke. At 145 feet from the portal the vein, which is 8 inches wide, follows a diagonal break, strike north 62 degrees west and dip vertical, for 10 feet to an approximately parallel shear, strike north. The vein then follows this shear to the face, where the intensely crushed quartz is 1 to 3 inches thick and the shear is filled with gouge 1 to 6 inches wide.

The quartz vein in the upper adit is 1 to 3 inches thick, contains abundant pyrite, and follows a strong shear 1 to 8 inches wide.

A sample of heavy pyrite taken from the vein in the creek bed at a point 15 feet above the portal of the lower adit assayed: Gold, 1.54 ounces per ton; silver, 0.5 ounce per ton. A sample across the 8-inch width of the vein, with scattered patches of pyrite, assayed: Gold, 0.40 ounce per ton; silver, 0.1 ounce per ton.

The western vein was seen in a stripping, elevation 1,450 feet, 700 feet upstream from the camp and 150 feet above the bed of the creek. The vein consists of a quartz stringer, 1 to 3 inches wide, that occasionally splits into several 1-inch stringers along the strike. The main quartz stringer, strike north 30 degrees east and dip 70 degrees southeastward, follows a shear 1 to 5 inches wide. Sulphides consisting of small amounts of pyrite are less abundant than in the eastern shear. Three samples taken along this vein assayed from trace to 0.30 ounce per ton in gold.

A third vein, described by Bancroft (1940, p. 33), in the bed of Fault Creek near the camp was discovered in 1938 when the early work was done on the property but was not found by the writer in 1945, as the showings had become covered with debris. Bancroft's (1940, p. 33) description of the vein follows:—

> The largest stringer in the bed of Fault Creek at the camp can be traced for 25 feet; it is 4 inches wide, strikes north 57 degrees west, and dips 46 degrees north. It is in sheared andesite and on the hanging-wall side of the major fault near a dyke of feldspar porphyry on the north. The stringers in the creek bed carry pyrite, pyrrhotite, and chalcopyrite in white quartz.

PROPERTIES NORTHWEST OF THE ZEBALLOS RIVER.

Boden. The Boden group (Fig. 2), northwest of the Zeballos River, is reported to include the Boden Nos. 1, 2, 3, and 4 Mineral Claims, staked in July, 1937, by Albert Bloom (deceased) and owned by the Bloom Estate and Jack Crossan, of Zeballos.

A lower group of showings extends from 1,100 feet elevation northwestward up the canyonous valley of the west fork of Maquinna Creek. A second group of showings, at 2,100 feet elevation, lies northwesterly over a summit and about 100 feet down a rock chimney, tributary to the west fork of Maquinna Creek.

The showings of both groups may be reached by following a blazed trail approximately a mile long leading from the Maquinna cabin northwesterly past the copper showings (p. 122), thence up the hillside on the northeastern side of Maquinna Creek to a point 750 feet in elevation and, entering the creek again, following the creek bed to the lower group of showings.

The writer saw these showings in 1937 and again in 1945, but since no work had been done on them since 1937 the following description is taken from the report based on the earlier examination (Stevenson, Lode-gold Deposits, 1938, pp. 22, 23):—

The first group of showings is on a strong shear, striking east and west, dipping 72 degrees north, that has been delineated by the chimney-like draw of the creek. The shear ranges from 6 inches to 2 feet in width and contains for the most part crushed rock and gouge with disseminated fine-grained pyrite and arsenopyrite; quartz is not abundant; calcite occurs frequently as lenses, ranging from 1 to 12 inches in thickness and from 1 foot to several feet in length; this calcite is a white, very coarsely cleaved variety.

The first showing in this group is a cut in the northeasterly wall of the canyon at an elevation of 1,100 feet. This cut exposes a zone of crushed rock and gouge 2 feet wide with a good hanging-wall; the minerals consist of fragmentary quartz, calcite, and the sulphides—pyrite, sphalerite, and finely disseminated arsenopyrite; the sulphides are not abundant. A sample of this material assayed: Gold, 0.10 oz. per ton; silver, trace. The rocks comprise granodiorite lying some 20 feet south of the cut and greenstone within the cut; the contact in this vicinity striking east and west.

Farther up this canyon at the forks with a second one at an elevation of 1,550 feet, diggings on the same break expose a 2-foot shear containing abundant gouge and broken fragments of calcite and greenstone; the wall-rock is a hybrid contact phase of the greenstone.

This shear was followed up the rock chimney to an elevation of 1,900 feet, beyond which travel was impossible; however, the shear appears to continue. It may be noted that, where left, the shear contained, in addition to the lenticular, coarsely cleaved calcite, a silicified layer 6 inches thick containing disseminated patches of pyrrhotite.

The second group of showings is reached by following an ill-marked route north-westerly up the hillside on the south-westerly side of the last-described creek branch, crossing a divide or summit at an elevation of 2,300 feet, and dropping down a rock chimney into the head of a westerly-trending draw at an elevation of 2,100 feet.

The showings consist of some mineralization, in an east-west zone 4 feet wide, that consists of slight shearing and abundant silicification of the greenstone; the zone, well washed by the creek, is exposed up the stream for approximately 150 feet.

Lenses of white calcite border the south wall of this zone; elsewhere in the silicified rock of the zone there are one-half to 2-inch quartz ribs, with granular calcite, blebby pyrite, and sphalerite. Both sulphides are scarce in amount and disseminated in wide intervals in the quartz. One sample of the silicified and pyritized greenstone and three samples of the quartz-sulphide veinlets assayed traces only in gold and silver. At one place, in the north wall of the zone, a quartz rib with considerable pyrrhotite occurs; a sample of this assayed traces only in gold and silver. A sample of grey-black gouge in a seam 2 to 4 inches thick along the shear also assayed only traces in gold and silver.

The rocks adjacent to the zone comprise greenstone, much of it leached and carbonatized by ankeritic carbonate, that is cut by an 8-foot diabase dyke striking north 80 degrees east.

Maquinna (Green Light).

This property, about 1,500 feet northwesterly from the Zeballos River opposite the Privateer, formerly comprised the Maquinna Nos. 1, 2, 3, and 4 Mineral Claims, owned by West Zeballos Gold Mines, Limited, incorporated in 1938 and dissolved in 1943. In July, 1945, the ground was held as the Green Light Nos. 1, 2, 3, and 4 claims, staked in 1943 by Samuel Ray.

After preliminary exploration, consisting of stripping and open-cutting, the two main adits (Fig. 35) were started in September, 1938, to explore the downward extension of a vein found on the surface. Work in them continued to late in 1939, but no production was recorded from the property.

The workings consist of two short adits, at an elevation of 900 feet on the north branch of the east fork of Maquinna Creek (Fig. 2), and a group of four lower adits, two short and two longer ones, about 1,800 feet easterly from the upper adits (Figs. 2 and 35). Several strippings and open-cuts, now sloughed, were dug between these two groups of underground workings, and some were dug up the creek westerly from the upper adits. The strike-length of the vein between the two main groups of workings is about 1,800 feet. This length may be extended a further 400 feet west-southwesterly to the farthest cut on the west fork of Maquinna Creek.

The two upper adits, elevation 900 feet, were driven from opposite sides of the creek. The eastern adit was driven north 70 degrees east for 20 feet along the vein shear, dip 75 to 80 degrees north. The shear is 18 inches wide in the adit and contains a fairly continuous lens of quartz 2 to 6 inches wide. The western adit, 5 feet lower and 61 feet west of the other, has been driven westerly for a reported distance of 55 feet. A cave 48 feet from the portal prevented the writer from reaching the face. The vein shear, where followed by this adit, is 30 inches wide and consists of crushed rock and considerable gouge, with scattered pyrite grains and fragments of broken vein quartz an eighth of an inch in diameter. Apparently movement along the vein shear, here striking nearly due east, has broken the vein quartz more than elsewhere along the vein shear. It may be noted that east-west is one of the directions of principal shear in the district (p. 45).

About 400 feet westerly along the strike of the shear, an open-cut has been driven 3 feet into the north bank of the creek, at elevation 1,120 feet, across what appears to be the westerly continuation of the vein shear. The shear, strike east and dip 80 degrees north, is about 18 inches wide and contains up to 14 inches of quartz mineralized with small amounts of arsenopyrite, pyrite, and sphalerite. It is reported that during 1937 and 1938 the vein shear was traced up the creek bed to a point 1,000 feet westerly from the upper adits, but when the writer examined the showings in 1945, without a guide, slides and creek wash prevented easy tracing of the vein beyond the open-cut mentioned.

A few pits and small open-cuts extend diagonally in an east-northeasterly direction and served to trace the vein down the hillside to the lower adits. These surface workings were dug in 1937 and 1938 and in 1945 were largely sloughed and were therefore not examined in detail.

The lower workings, consisting of four adits, are shown in detail in Figure 35, and their position with respect to the upper adits may be seen in Figure 2.

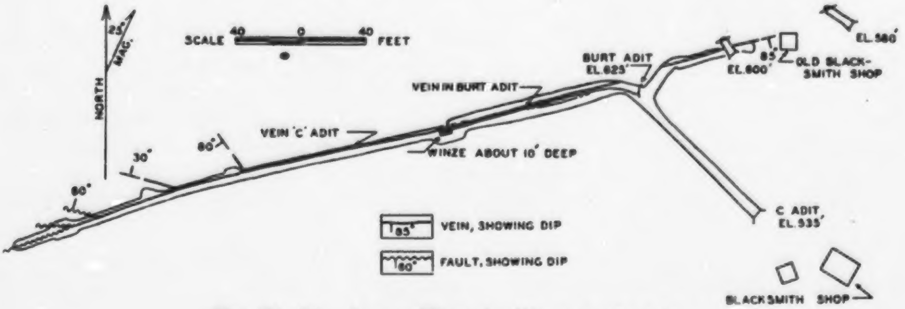

Fig. 35. Maquinna: Plan of adits on main vein.

The lowest or "C" adit was driven northwesterly as a crosscut for 115 feet to the vein, on which drifts were driven southwesterly and northeasterly. Along the drift southwesterly from the crosscut, the vein, strike north 70 degrees east, is 8 to 12 inches wide to 130 feet, then, as the strike turns to north 72 degrees east, the vein narrows and is accompanied by considerable gouge to 220 feet, where the vein returns to the north 70 degrees east strike and is 6 to 14 inches wide to 330 feet. However, from here to the face, although maintaining the more southerly strike, the vein narrows, and at the face only the vein shear, consisting of 4 inches of crushed rock and gouge, is found. In the drift northeasterly from the crosscut, the vein, strike north 70 degrees east, is much wider, ranging in width from 14 to 30 inches. A feature of the vein in this drift is a fairly persistent ribbon of quartz, a knife-edge to 2 inches wide with abundant arsenopyrite, along the south or hangingwall side of the vein.

One hundred and twenty feet from the crosscut in the southwesterly drift, a winze, now full of water, was sunk about 10 feet on the vein. The quartz at this point is 12 inches wide, and the vein shear extends for a width of 42 inches. It is reported that the vein was richer than average at this place.

For most of its length on the vein the Burt adit (Fig. 35) has been driven as a drift. The part of the vein explored by this adit, strike north 76 degrees west and dip 80 degrees south, is usually 6 inches wide and is, therefore, in general, narrower than *in the "C" adit.* The vein shear, 6 to 18 inches wide, is well defined.

The short adit 60 feet east-northeasterly from the Burt adit crosscuts quartz 1 foot wide, and the other short adit 70 feet farther east-northeasterly crosscuts quartz 6 inches wide.

The quartz vein in these adits is usually massive, but in some places, as in the northeast drift in the "C" adit, it is ribboned, layers of quartz, 1 to 2 inches wide, being separated by partings of schistose rock an eighth of an inch wide. The quartz, in places, is coarsely crystalline and vuggy. It is mineralized with arsenopyrite and small amounts of pyrrhotite, chalcopyrite, sphalerite, and galena. In the northeasterly drift in the "C" adit, arsenopyrite is abundant in a quartz-arsenopyrite layer, a knife-edge to 2 inches wide on the south wall of the vein. Patches of coarsely cleaved calcite are found at a few places in the vein.

With the exception of a section of the vein about 4 feet long at the winze on "C" adit, assays of samples taken along the vein were not sufficiently encouraging to warrant mining. The ore is reported to have contained usually less than 0.2 ounce of gold per ton.

Some open-cuts were made, about 1932, to explore chalcopyrite-magnetite mineralization in limestone and closely associated limy tuffs about 600 feet south-southeasterly from the "C" adit. These showings had been found several years earlier than the quartz vein described above. In 1932 they were covered by the Blackbird and Bluebird claims, and from 1933 until staked as the Maquinna they comprised what was known as the Jack O'Spades property.

At the showings, strippings, open-cuts, and a short adit explore a band of mixed dacite, limestone, and tan garnet, about 30 feet wide, that contains scattered clusters and streaks of mixed magnetite and chalcopyrite with small amounts of pyrite and pyrrhotite. The white altered rock with the tan garnet on the north side lies between grey crystalline limestone of unknown width on the south and green hornfelsed tuff on the north. Streaks of tan garnet extend into the tuff. Small amounts of other lime-silicate minerals, such as epidote, wollastonite, and actinolite, are found with the white rock.

The main working extends westerly for 18 feet as an open-cut and continues in the same direction for a further 18 feet as an adit. The cut and adit are in dark-green altered tuff, in part replaced by streaks of tan garnet and green diopside 1 to 12 inches wide, strike north 30 degrees east and dip 60 to 70 degrees northwest. No magnetite or chalcopyrite were seen in the walls of this working.

From a point 60 feet west-southwesterly from the portal of the adit a stripping extends west-southwesterly for 30 feet. This stripping exposes a band of white altered rock underlying rock consisting mainly of tan garnet, the contact striking north 50 degrees east and dipping 45 degrees southeastward. The white rock contains streaks, a few inches thick, of mixed chalcopyrite and magnetite.

Twenty-five feet south-southwesterly from the western end of this stripping, a trench extends for 20 feet along the base of a 15-foot bluff. This trench exposes grey limestone in contact with white altered rock on the north, the contact trending west-northwesterly. No mineralization was seen in this trench. Trenching extends intermittently west-northwesterly from the western end of this trench for approximately 80 feet along the same contact. At the western end of the line of trenches, tan garnet and clusters of magnetite and chalcopyrite were seen in the white rock.

Sixty feet westerly from the last point, a short stripping along a face 4 feet high exposes rock that is mainly tan garnet and contains scattered clusters of magnetite and chalcopyrite.

Omega. This property, on Pandora Creek (Fig. 2), originally consisted of the Omega Nos. 1, 2, 3, and 4, and Omega Fractional Mineral Claims, staked in 1937 and 1938 by John Hagmo and C. J. Heaney, and transferred to Torres-Zeballos Mines, Limited, 475 Howe Street, Vancouver. The claims have since lapsed. The one adit on the property was driven by the Torres-Zeballos Company in 1938 and 1939. No further work was done on the property, and in 1942 the charter of the company was cancelled.

The camp may be reached from the Ford bridge across the Zeballos River by following a tractor-road for three-quarters of a mile to the lower adit, elevation 535 feet, on the Maquinna property, thence by foot-trail easterly to Pandora Creek and up the west bank of the creek for about a mile to a cabin, elevation 1,290 feet, on the west bank of the creek. The cabin and workings are in a steep-walled, but accessible part of the creek; upstream and downstream from here the creek flows through canyons and most of it is inaccessible.

The property is underlain by andesite and fine diorite (Fig. 2), and the main working is near the contact between the two rock types. Both types are found in the workings, with andesite the more abundant.

The main showing is a shear, 4 to 12 inches wide, that contains crushed rock and gouge and occasional quartz-calcite lenses, ranging in size from 4 inches by 3 feet to 12 inches by 3 feet. The quartz contains moderate amounts of pyrite and small amounts of fine-grained arsenopyrite, chalcopyrite, sphalerite, and galena.

The main working, elevation 1,335 feet, on the northeast side of the creek has been driven from near creek level north 40 degrees east as an open-cut for 10 feet, then as an adit in the same direction for 16 feet, then north 58 degrees east for 93 feet, and then north 80 degrees east for 34 feet to the face.

In the first 38 feet the working follows a strong shear, strike north 52 degrees east and dip 80 degrees southeast. At 38 feet the main shear is joined by a vertical shear, strike north 60 degrees east, which comes into the northwestern wall of the adit at a point 15 feet within the portal of the adit. The main shear, strike north 50 degrees west and dip 70 degrees northeast, continues to a point 109 feet from the portal, where it is offset by a fault an inch wide. From the portal to this point, lenses of quartz, 4 to 12 inches thick by 3 feet long, were seen at several places along the shear. From the fault the adit was driven north 80 degrees east for 34 feet to the face along a narrow stringer of calcite and quartz, but the main vein shear does not appear to have been found.

Samples of vein matter from the adit failed to show encouraging assays in either gold or base metals.

Two hundred feet upstream from the adit a small cut in the southwest bank of the creek exposes a barren calcite vein, half an inch wide, in a narrow shear, strike north 70 degrees west and dip 65 degrees northeast.

Small lenses of pyrrhotite and chalcopyrite in limestone carrying small amounts of gold have been reported elsewhere on the property, but, as very little work has been done on them, the writer did not examine them.

Peerless. This property, on Pandora Creek upstream from the Omega, was prospected by Pioneer Gold Mines, Limited, in 1937 and 1938; since then no work appears to have been done and the claims have lapsed. The writer examined the showings in 1945.

The old tent camp, elevation 1,960 feet, and workings are reached from the Omega cabin by a steep foot-trail (not shown on Fig. 2), 1,500 feet long, that follows the southwest bank of Pandora Creek.

The main showing is in the bed of the creek, at a point where it forks, about 50 feet lower in elevation than the tent camp. Here a quartz vein, strike north 65 degrees east, dip vertical, and 2 inches wide, follows the contact between a feldspar porphyry dyke and feldspathized andesite. The quartz contains abundant calcite and small amounts of sphalerite and chalcopyrite.

The vein is well exposed in the bedrock of the creek. If any surface workings prospected the extension of the vein away from the creek, they have long since been destroyed or obscured by dirt slides.

Pandora.

The Pandora Nos. 1 to 8 Mineral Claims, on Pandora (Granite) Creek near its confluence with the Zeballos River (Fig. 2), are held by record by Jack Crossan, of Zeballos. Most of the work on this property was done in 1939, and no production has been recorded.

Bedrock in the southern part of the property is largely covered by valley fill, but outcrops show that the northern section is underlain by white granodiorite and fine-grained diorite (Fig. 2).

The exposures indicate a strong shear zone in white granodiorite, 4 inches to 6 feet wide, strike north 58 degrees east and dip vertical. A well-defined gouge seam, 4 inches wide, in this shear zone contains fragments of quartz up to 1 inch in diameter mineralized with a small amount of pyrite. The fragments of quartz indicate the presence, before crushing, of a quartz vein along the shear zone.

A shear zone containing mineralized quartz is reported to have been well exposed by open-cuts and stripping in 1939, but in 1945 it had been largely obscured by overburden and rubble brought down by a watercourse that follows the shear to Blacksand Creek.

Cordova.

This property, on the northeast side of Blacksand Creek, is reported to consist of the Cordova, Cordova No. 1, Cordova Fraction, Ridge Fraction, Siwash, and Siwash No. 1 Mineral Claims, staked in 1937–38 by R. V. Murphy, of Zeballos, and held by record by Murphy and F. R. Moore. As these claims have not been surveyed, their outlines are not shown in Figure 2; however, the position of the principal workings is shown. The only production recorded is a shipment of 1 ton made in 1939, containing 5 ounces of gold, 1 ounce of silver, and 8 pounds of lead.

A cabin, elevation 1,310 feet, may be reached from the Ford bridge across the Zeballos River by 0.7 mile of tractor-road and 0.7 mile of foot-trail. From the cabin a foot-trail, 1,500 feet long, leads northwesterly to the one adit, elevation 1,930 feet.

Light-coloured granodiorite underlies the eastern part of the property and fine-grained diorite the western part. The north-northwesterly striking contact between the two rock types lies close to the one adit (Fig. 2).

The principal workings are on the Cordova No. 1 claim and consist of an adit and three open-cuts above it (Fig. 36). The adit, No. 1 cut, and No. 3 cut are on the main shear, strike north 63 degrees east and dip 75 to 85 degrees southeastward. The shear contains mineralized quartz ranging in width from 0 to 10 inches. Much of the quartz has been broken and crushed and is strung out along the shear as lenses separated by barren stretches. The mineralized quartz contains a small amount of gold. The main vein is reported to have been traced in scattered small cuts and strippings northeasterly from No. 3 cut over the hill onto the Cordova claim.

At 7 feet from the portal the adit intersects a fault, strike north 78 degrees west and dip vertical, containing 2 inches of crushed rock and gouge, from which low assays in copper have been reported. Twenty-five feet from the portal the adit intersects the vein shear and follows it for 27 feet to the face as of August 11, 1945. The vein shear, which is 2 to 18 inches wide, contains gouge, crushed rock, and crushed vein matter, consisting of quartz, with abundant pyrite and arsenopyrite, in disconnected lenses from a few inches to 3 feet long; these mineralized lenses are reported to contain small amounts of gold. The largest lens seen, 10 feet from the face, was 3 to 10 inches wide and 3 feet long.

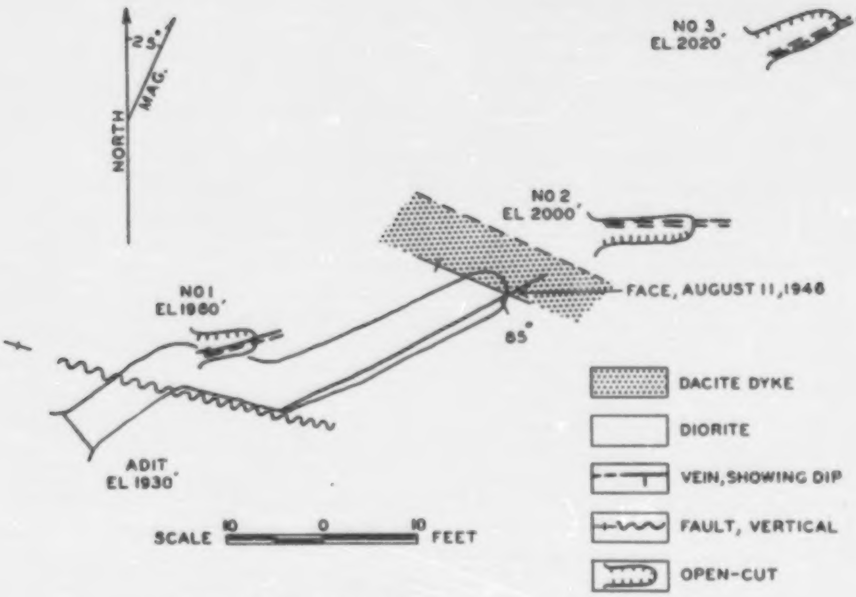

Fig. 36. Cordova: Adit and open-cuts on main vein.

The rock in the open-cut leading to the adit is a mixture of fine diorite and white granodiorite, and the rock in the adit is mainly fine diorite, but a porphyritic dacite dyke, strike north 78 degrees west and dip vertical, has been intersected in the face.

No. 1 open-cut, driven easterly for 6 feet to a face 6 feet high by 3 feet wide, followed 3 inches of quartz on the northwest wall of a shear 5 inches to 2 feet wide. In this open-cut, fine-grained diorite is cut by narrow dykes of white granodiorite.

No. 2 open-cut, not on the main vein shear, has been driven easterly for 10 feet to a face 7 feet high by 2 feet wide along quartz stringers 1 to 2 inches wide that follow a shear zone 2 feet wide. Seams of very fine-grained arsenopyrite, unaccompanied by quartz, follow the shear in places. This shear strikes towards, but has not been traced into, the main shear. The rock in the cut is white granodiorite.

No. 3 open-cut has been driven northeasterly for 8 feet to a face 5 feet high by 3 feet wide, following the main vein shear, 6 to 12 inches wide, which contains quartz ranging in width from a knife-edge to 8 inches. The quartz contains moderate amounts of arsenopyrite and pyrite.

The vein shear continues northeasterly up a creek bed from No. 3 cut and is reported to have been found several hundred feet northeasterly on the mountainside sloping easterly into Lime Creek.

F.L., Ridge.

Several bodies of almost pure magnetite are found at or near the contact between limestone and andesite crossing and extending southerly from Blacksand Creek, and lower-grade magnetite mineralization continues along the contact northerly from the creek. These magnetite bodies are on claims of the F.L. group and on the Extension No. 2 claim (L. 2009).

About 1,500 feet farther east a body of magnetite is indicated by closely spaced outcrops in an area 300 feet long and 40 feet wide. This body trends easterly, crossing the eastern boundary of the Extension No. 4 claim (L. 2011) into the Ridge Fraction.

F.L.—Anyox Metals, Limited, controlled by Ventures, Limited, holds the following Crown-granted claims by lease from the Ford Iron Syndicate: F.L. (L. 1999), F.L. No. 2 (L. 2000), F.L. No. 3 (L. 2001), F.L. No. 4 (L. 2002), F.L. No. 6 (L. 2004). The following recorded mineral claims are also held by lease from the same syndicate: F.L. No. 1 (L. 2005) and F.L. No. 8 (L. 2006). An agreement between A. Morod, R. V. Murphy, and others, on the one part, and Anyox Metals, Limited, on the other, transfers all rights in iron ore on the Crown-granted claims Extension No. 1 (L. 2008), Extension No. 2 (L. 2009), Extension No. 3 (L. 2010), Extension No. 4 (L. 2011), and Barnacle Fractional (L. 2012) to Anyox Metals, Limited. The F.E. Mineral Claim (L. 2007), located in 1942 and owned by Anyox Metals, Limited, is held by record.

The claims are on the northwest side of the Zeballos River and extend across the headwaters of Blacksand Creek between elevations of 2,400 and 2,850 feet.

The F.L. cabin, elevation 2,150 feet, may be reached from the Ford bridge, elevation 175 feet, across the Zeballos River by a mile of pack-horse trail, thence by a mile of steep foot-trail up the mountainside to the cabin. From the cabin a foot-trail leads 1,000 feet northerly up the mountainside to the southern end of the showings (Fig. 2).

Bodies of pure magnetite are well exposed in steep bluffs on the F.L. claims and the Extension No. 2. In 1941 two X-ray diamond-drill holes were drilled to test the downward extent of the longest magnetite body. No further exploratory work was done either on the high-grade magnetite bodies or on lower-grade mineralization found north of them.

The main showing consists of a bluff of magnetite on the steep mountainside, which slopes, on an average of 45 degrees, into Blacksand Creek. The magnetite bluff is cut across by several canyons, that of Blacksand Creek, a small one north of Blacksand Creek, and two small ones south of the creek.

The magnetite occurs along the contact of limestone and andesite near the southwestern corner of a large body of limestone (Fig. 2). The typical limestone is light green to white, coarsely crystalline, and remarkably free from lime-silicate minerals. Areal mapping indicates that the limestone overlies the andesite and that the rocks are folded into a northeasterly trending syncline, the trough of which plunges northeasterly (*see* Fig. 2 and discussion of structure on p. 37 of this report). In the main magnetite body the two drill-hole intersections of the magnetite indicate westward or outward dips for the contacts. This divergence from expected eastward dips may be due to small local folds, similar to a small fold exposed in the canyon of Blacksand Creek where it cuts through the contact between the limestone and magnetite.

The andesitic greenstone is part of a long narrow remnant that extends southwesterly from the magnetite and is bordered on the northwest and southeast by fine diorite cut by white granodiorite (*see* Fig. 2). The andesite near both ends of the magnetite orebody has been largely replaced by the calcium silicates epidote, andradite garnet, and actinolite, and locally the rock may consist wholly of granular epidote.

Diabase dykes, up to 6 feet wide, cut the limestone, and, although not seen in actual contact, presumably also cut the andesite but not the magnetite orebody.

Feldspar porphyry dykes, 6 to 25 feet wide, cut the andesite, limestone, and magnetite.

Four bodies of relatively high-grade magnetite ore have been found and are shown, with the near-by geology, in Figure 37.

The main magnetite orebody extends southward from Blacksand Creek for 450 feet. Two smaller orebodies lie along the contact southerly from the large body, and another smaller one lies in andesite 200 feet westerly from the contact. Magnetite mineralization extends for 700 feet northerly from Blacksand Creek, but just north of the creek silicates appear, becoming increasingly abundant to the north, and at 700 feet comprise 75 per cent. of the replacement body.

The surface outcrops of the main magnetite orebody and the section cut by Drill Hole No. 1 (*see* section in Fig. 37) show a true width for the orebody of about 100 feet. The section through Drill Hole No. 1 shows a depth of about 250 feet but, as Drill Hole No. 2 did not intersect any magnetite, the depth at this point is less than

For paragraph beginning "The magnetite occurs along the contact.." substitute -

The magnetite occurs near the southwestern corner of a large body of limestone (Fig. 2), along the contact of limestone and andesite that overlies it. The typical limestone is light green to white, coarsely crystalline, and remarkably free from lime-silicate minerals. Areal mapping indicates that the limestone and the overlying andesite are folded into a southwesterly trending anticline, the crest of which plunges southwesterly (see p. 37). In the main magnetite body the two drill-hole intersections of the magnetite indicate westward dips for the contacts; such a direction is to be expected from the above concept of the structure.

For the last three lines of the page substitute -

Hole No. 2 (see section in Fig. 37) show a true width for the orebody of about 100 feet. The section through Drill Hole No. 2 shows a depth of about 250 feet, but as Drill Hole No. 1 did not intersect any magnetite, the depth at this point is less than

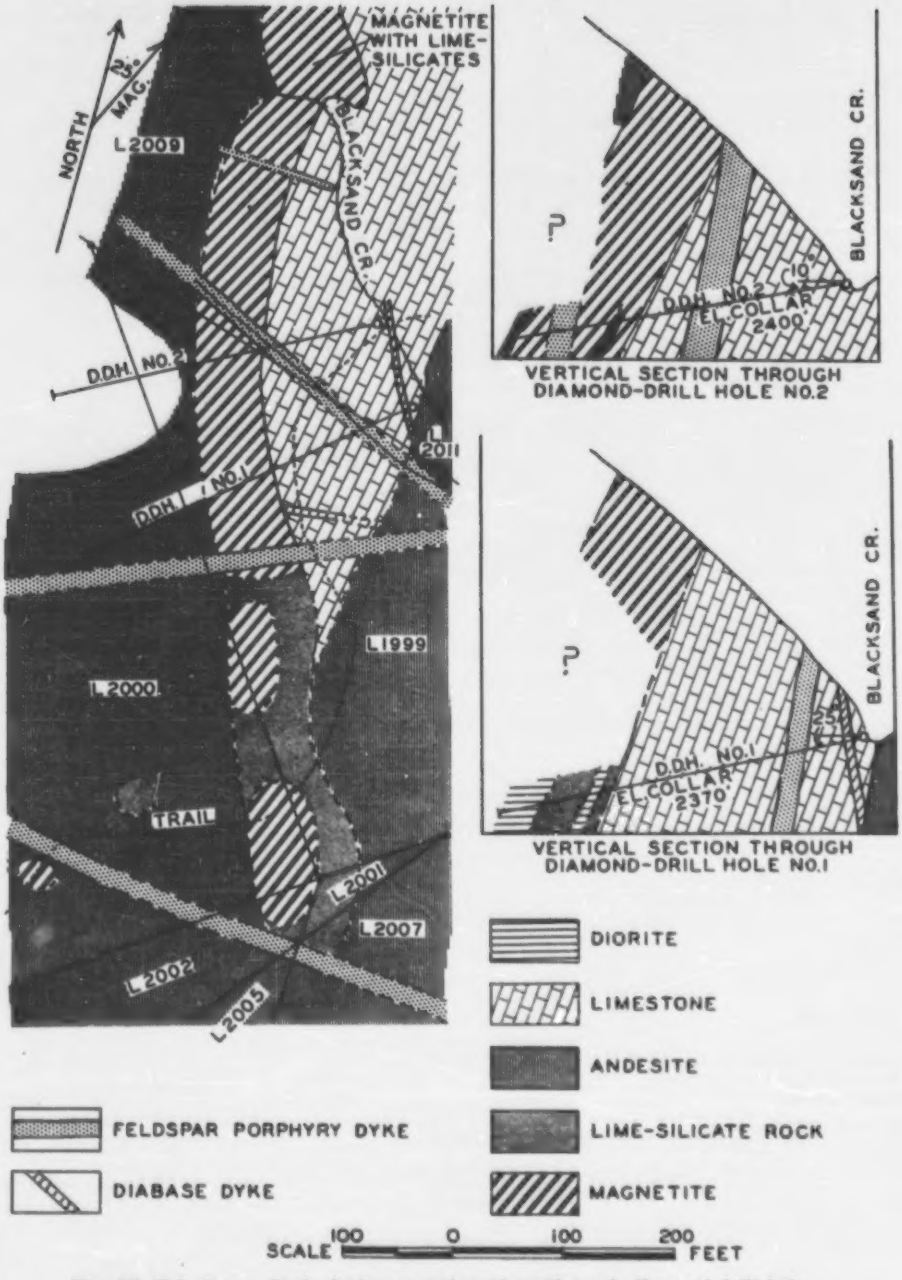
MAGNETITE WITH LIME-SILICATES
NORTH
MAG.
2½°
L2009
BLACKSAND CR.
D.D.H. NO. 2
D.D.H. NO. 1
L 2011
L1999
L2000
TRAIL
L2001
L2007
L2002
L2005
?
BLACKSAND CR.
D.D.H. NO. 2
10°
EL. COLLAR 2400'
VERTICAL SECTION THROUGH DIAMOND-DRILL HOLE NO. 2
?
BLACKSAND CR.
25°
D.D.H. NO. 1
EL. COLLAR 2370'
VERTICAL SECTION THROUGH DIAMOND-DRILL HOLE NO. 1
DIORITE
LIMESTONE
ANDESITE
LIME-SILICATE ROCK
MAGNETITE
FELDSPAR PORPHYRY DYKE
DIABASE DYKE
SCALE
100
0
100
200
FEET

Fig. 87. F.L. Iron: Geological map and sections through diamond-drill holes.

300 feet, the depth at which the hole enters the projection of the magnetite down the dip.

The magnetite orebody consists of a large lens of relatively pure magnetite. Silicates and sulphides are not recognized, either as large masses or as disseminated grains. Most of the magnetite is massive and very fine grained, almost dense in places, but a small amount of it is in octahedral crystals one-eighth of an inch to half an inch in diameter. No difference in tenor of iron, as between the fine-grained or dense and the more crystalline phases, was noted.

Assays of magnetite ore from the main outcrop are given in the following table:—

	1.	2.	3.	4.	5.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Iron (Fe)	67.8	67.5	67.9	67.7	68.7
Titania (TiO_2)	0.08	Trace	Trace	Trace	Trace
Sulphur (S)	0.1	0.06	0.3	0.2	0.06
Phosphorus (P)	0.001	0.01	0.01	Trace	Trace
Silica (SiO_2)	1.06	2.0	2.1	2.3	1.85
Manganese (Mn)	——	0.2	0.15	0.2	0.3

1. Sample (200 lb.) taken at random along the main magnetite bluff in 1939 by associates of Mr. Ford, owners at that time.

2 to 5. Small samples of typical ore taken by the writer at four widely spaced intervals along the length of the main magnetite bluff.

Ridge.—About 1,500 feet east of the main magnetite showings on Blacksand Creek, an area, 300 feet long by 40 feet wide, of closely spaced outcrops of magnetite extends easterly across the boundary from Extension No. 4 claim (L. 2011) into the Ridge Fraction. The outcrop area (Fig. 2) is along the contact between limestone on the north and fine diorite on the south. At the west end of the outcrop area, andesite is in contact with limestone. Two 4-foot feldspar porphyry dykes cut the magnetite and the surrounding rocks. The magnetite in these outcrops is massive to crystalline and free from visible sulphides or lime silicates.

The assays of samples of magnetite taken from these outcrops are given in the following table; their position is given with respect to the location post on the east boundary line of the Extension No. 4 claim (L. 2011):—

	LOCATION, REFERRED TO CLAIM LINE.			
	70 Ft. West.	60 Ft. West.	100 Ft. East.	140 Ft. East.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Iron (Fe)	68.18	68.53	67.72	68.84
Titania (TiO_2)	0.008	0.003	0.004	0.002
Sulphur (S)	0.003	0.003	0.003	0.02
Phosphorus (P)	0.011	0.013	0.006	0.014
Silica (SiO_2)	2.64	2.46	3.08	2.12
Manganese (Mn)	0.032	0.039	0.039	0.046

Barnacle (Morod-Maclean Showings).

Several gold-bearing quartz veins in shear zones have been found on the Barnacle group on the mountainside between Blacksand and Lime Creeks. The Barnacle group consists of the Crown-granted claims Extension No. 1 (L. 2008), Extension No. 2 (L. 2009), Extension No. 3 (L. 2010), and Extension No. 4 (L. 2011), staked in 1938; Barnacle Fractional (L. 2012), staked in 1939; and the recorded K.P.O., staked in 1944, owned by Andy Morod and William Maclean.

The showings on which the early and greater amount of work has been done, but on which no work was being done in 1946, are on the Extension No. 1 (L. 2008) and Extension No. 3 (L. 2010) claims. In 1946 Messrs. Morod and Maclean were working on the Extension No. 4 (L. 2011) claim southerly from the older workings.

A cabin, elevation 2,280 feet, which was used while the early work was being done, may be reached from the Ford suspension bridge, elevation 175 feet, across the Zeballos River, by 1½ miles of pack-horse trail to the Labella cabin, elevation 400 feet, on the east bank of Lime Creek, thence by 1½ miles of good foot-trail up the west side of the creek to the cabin, approximately 600 feet above the creek. A trail, 1,200 feet long, leads south-southwesterly to four short adits, each on a different vein shear.

The rock in these adits and on the near-by hillside is a mixture of fine-grained diorite and andesite, with the andesite predominating. The contact with limestone is to the southeast of the showings (*see* Fig. 2).

No. 1 adit (Fig. 38) on the Extension No. 1 (L. 2008) claim has been driven south for 34 feet along a shear zone, 4 feet wide, strike northerly and dip 65 degrees west, that contains a lenticular quartz vein 0 to 6 inches thick. This quartz vein extends for about 200 feet northward down the floor of a rock chimney on a slope of about 60 degrees.

No. 2 adit on the Extension No. 3 (L. 2010) claim is the main adit and follows a gold-bearing quartz vein, strike northerly and dip vertical. The quartz, 2 to 4 inches wide, is in the centre of a strong shear zone, 2 feet wide, in andesite that contains patches of diorite and brown garnet.

The quartz is vuggy, and, near the surface, many of the cavities in the quartz are filled with earthy limonite, indicating the former presence of sulphides. Occasional residual chalcopyrite and pyrrhotite are seen. Numerous specimens of rusty quartz, containing visible gold, were obtained in drifting. The vein in the face, as of September 16, 1945, consisted of three-quarters of an inch of crushed quartz on the east side of the shear. It was the owners' intention to drive on the vein in this adit until it intersected a northwesterly striking, vertical quartz vein, 3 to 4 inches wide, that outcrops on the rock bluff about 100 feet above. About 250 feet above the adit a small stripping and pit on this cross-vein expose rusty vuggy quartz that contains specks of visible gold. At several places on the nose of the ridge westerly from these workings, vein shears, some with a few inches of quartz, have been exposed by shallow pits; these shears follow feldspar porphyry dykes. Specks of free gold may be seen in much of the quartz and may be panned from the rusty crushed material of shear zones.

No. 3 adit, also on the Extension No. 1 claim and partly caved at the portal, had been driven southerly for 18 feet along lenticular quartz veins, 1 to 8 inches wide, that were reported to be 10 inches wide 100 feet above the adit. The vein matter is thoroughly oxidized. The vein follows a shear, strike north, dip 85 degrees west, and 1 foot wide. It is reported that 1½ tons of high-grade ore, averaging 3.13 ounces of gold per ton, was taken from the open-cut leading into this adit and back-packed down the mountain to the truck-road at the Ford bridge. The rock in this adit is mainly andesite with patches of brown garnet.

At a point, elevation 3,060 feet, on the Extension No. 4 claim (L. 2011) and about 500 feet south-southwesterly along the mountainside from No. 3 adit, a fourth adit has been driven north 22 degrees west as an open-cut for 15 feet and then as an adit for 15 feet along the wall of a 3-foot light-green diabase dyke that cuts fine-grained andesite. Three gouge seams, 1 to 6 inches wide, in the east half of the dyke are followed by veins of white vuggy quartz, 1 to 3 inches wide. Coarse gold is reported to have been found in the vein quartz from this adit.

In September, 1946, Morod and Maclean were prospecting a lenticular quartz-sulphide vein, 6 inches to 2 feet wide, on the Extension No. 4 claim (L. 2011) approxi-

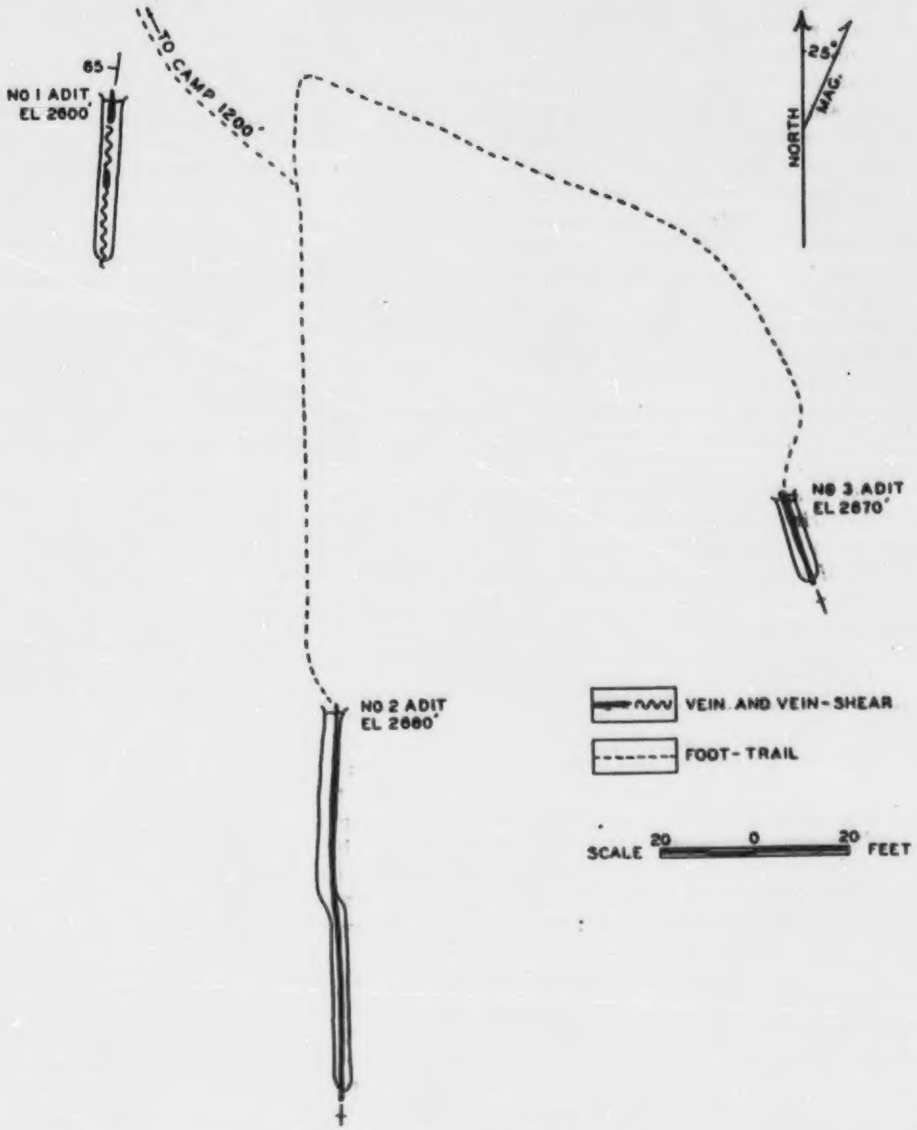
65
NO 1 ADIT
EL 2600'
TO CAMP 1200'
NORTH
MAG.
25°
NO 3 ADIT
EL 2870'
NO 2 ADIT
EL 2660'
VEIN AND VEIN-SHEAR
FOOT-TRAIL
SCALE
20
0
20
FEET

Fig. 38. Barnacle: Main workings.

mately 1,600 feet south of the Barnacle adits (Fig. 2). The vein has been stripped at several places along its strike, and an adit has been driven by hand for 46 feet.

The vein follows the west wall of a fine-grained andesite dyke, strike north 23 degrees east and dip vertical, that cuts massive crystalline limestone. Specks of fine gold may be seen in silicified vein matter at the surface.

The vein outcrops for 200 feet southerly down the hillside from the adit and for 60 feet northerly up the hillside. The owners plan to drive the adit northerly to the intersection of the dyke in the adit with a light-coloured andesite dyke, strike north

35 degrees west and dip vertical, that outcrops on the surface 60 feet up the hill from the portal.

At the portal of the adit the vein is 16 inches wide, but 15 feet from the portal it pinches to 2 inches, and from there to the face disconnected lenses of the vein matter are found along the wall of the dyke.

Lucky Strike. In 1938 the four Lucky Strike claims and two Vancouver Girl claims at the headwaters of the westerly fork of Lime Creek were held by location. During September and October of that year, surface work was done on two veins by Pioneer Gold Mines, Limited, but since that time very little work has been done, and the claims have been abandoned. The showings are on the ridge above the Barnacle cabin and may be reached from that cabin by a foot-trail (not shown in Fig. 2) that follows the westerly fork of Lime Creek.

One vein, referred to by some as the Vancouver Girl shear and by others as the Lucky Strike shear, strike north 47 degrees east and dip vertical, extends from the headwaters of the western fork of Lime Creek southwesterly across the ridge to the Kaouk River slope for several hundred feet. The maximum width of the shear is 6 inches, and in places the shear contains quartz, 2 to 3 inches wide, mineralized with abundant pyrite. It is reported that assays up to a quarter of an ounce of gold per ton have been obtained from the vein matter. The shear follows a feldspar porphyry dyke a few feet wide in diorite-granodiorite breccia.

The second vein, known as the Free Gold or Lucky Strike vein, about a quarter of a mile northerly from the first vein and about 300 feet due east of the highest point (elevation 4,041 feet) on the ridge, has been prospected by a few pits and strippings. The vein, strike north 50 degrees east and dip vertical, consists of 1 to 6 inches of rusty quartz in a shear, up to 6 inches wide, that follows a feldspar porphyry dyke, 3 feet wide, in diorite-granodiorite breccia. The quartz contains some pyrite and pyrrhotite, and it is reported that gold may be panned from the oxidized material.

Churchill. The Churchill group is at the headwaters of Lime and Fault Creeks and extends northwesterly to the divide between these creeks and Kaouk River, approximately half a mile beyond the north edge of the map-area. This group is reported to consist of the Churchill Fraction Nos. 1 and 2 and the Shear Fraction Mineral Claims, staked in 1941 by Sam N. Ray and owned jointly by Mr. Ray and J. W. Foster. The property was examined in 1944.

Bodies of magnetite and a gold-silver-lead vein are well exposed in natural outcrops. A few small pits were dug on the iron showings for sampling purposes, and several pits were dug to expose the gold-silver-lead vein, and two short diamond-drill holes were drilled towards it. In 1944 Privateer Mine, Limited, had the property under option, built 2½ miles of good pack-horse trail and a mile of foot-trail, and drilled two holes with a light diamond drill. Little other work was done on the property, and no production has been reported.

The property may be reached from the Ford suspension bridge across the Zeballos River by 2.4 miles of pack-horse trail up the Zeballos River and Lime Creek to the Churchill cabin, elevation 1,180 feet, thence by 1 mile of steep foot-trail to the tent camp, elevation 3,475 feet. The workings are about 1,500 feet beyond the camp.

The principal rocks on the property include limestone and diorite and dykes of diabase and aplite. The distribution of the principal rock types is shown in Figure 39.

The limestone is grey-weathering and is generally massive. Although extensive recrystallization has destroyed nearly all evidence of bedding, at one place thin beds of sandy limestone near the northeastern corner of the largest area of magnetite showings (Fig. 39) have retained their individuality sufficiently so that their attitude could be determined. These beds, strike north 30 degrees west and dip 45 degrees northeastward, indicate the strike and dip of the limestone, at least near the magnetite showings.

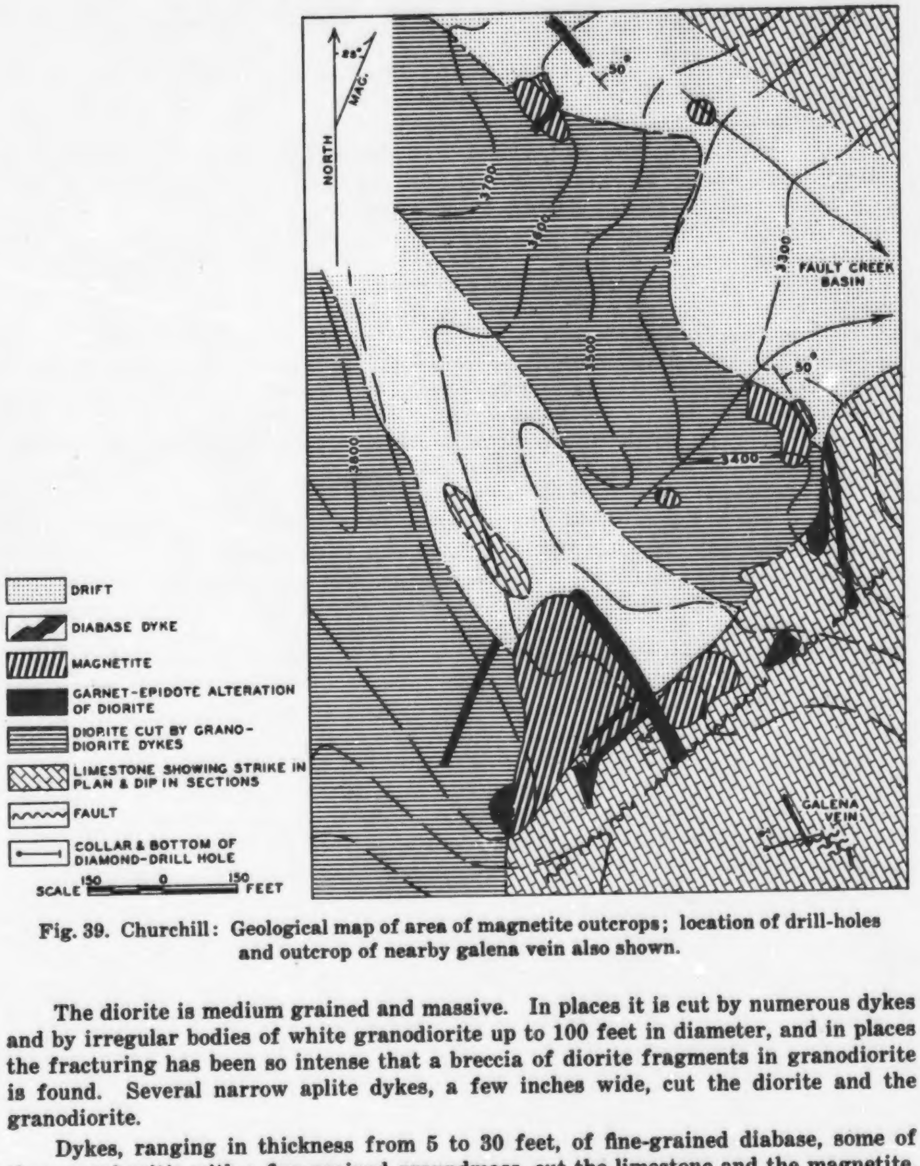
NORTH
MAG.
25°
50°
3700
3600
3500
3300
FAULT CREEK BASIN
80°
3400
3800
GALENA VEIN
DRIFT
DIABASE DYKE
MAGNETITE
GARNET-EPIDOTE ALTERATION OF DIORITE
DIORITE CUT BY GRANODIORITE DYKES
LIMESTONE SHOWING STRIKE IN PLAN & DIP IN SECTIONS
FAULT
COLLAR & BOTTOM OF DIAMOND-DRILL HOLE
SCALE 150 0 150 FEET

Fig. 39. Churchill: Geological map of area of magnetite outcrops; location of drill-holes and outcrop of nearby galena vein also shown.

The diorite is medium grained and massive. In places it is cut by numerous dykes and by irregular bodies of white granodiorite up to 100 feet in diameter, and in places the fracturing has been so intense that a breccia of diorite fragments in granodiorite is found. Several narrow aplite dykes, a few inches wide, cut the diorite and the granodiorite.

Dykes, ranging in thickness from 5 to 30 feet, of fine-grained diabase, some of them porphyritic with a fine-grained groundmass, cut the limestone and the magnetite, but none have been observed cutting either the diorite or the granodiorite.

At the southwestern corner of the largest exposure of magnetite, a patch of lime-silicate rock, consisting mainly of tan garnet and epidote, was found along the magnetite-diorite contact.

***Iron Showings.*—Bodies of iron minerals (magnetite with pyrrhotite and pyrite and hereafter referred to as magnetite) occur in limestone close to diorite and are well exposed in certain outcrops above timberline at the headwaters of Fault Creek (*see* Fig. 39). No work, other than the digging of a few small pits for sampling purposes, has been done on the showings.**

The bodies of magnetite are in the shape of lenses that trend northwesterly and, as indicated by the strike and dip with underlying limestone in an outcrop of magnetite 700 feet northeasterly from the largest area of magnetite, appear to dip northeastward in conformity with the dip of the limestone. The magnetite bodies have replaced the limestone at preferred places near its contact with the diorite because elliptical areas, a few inches long, of unreplaced limestone still remain in some of the magnetite outcrops.

The outcrop areas of the magnetite range from 2,250 to 68,500 square feet. Measurements of the thickness of the lenses are not possible.

The outcrops of the magnetite bodies are characterized by large areas of limonitic material alternating with patches of magnetite. In the largest outcrops, measuring from 100 to 200 feet in diameter, the limonitic areas measure up to 20 feet across and constitute up to approximately a tenth of the outcrop area and in some outcrops more than this amount.

The magnetite between the areas of limonitic material is usually free from limonite and weathers to a glistening coal-black surface of clean magnetite. Samples taken in areas of coal-black magnetite are usually not only high in iron but also low in sulphur.

Close to the surface the limonitic material consists principally of limonite with a little residual pyrrhotite and very small amounts of magnetite. However, sample pits dug into parts of the outcrops covered by limonite pass first through 2 to 16 inches of limonite then into relatively unoxidized material that consists of magnetite with abundant pyrrhotite. The presence of pyrrhotite below limonite in these pits indicates that the limonite is a surface alteration product, principally of the pyrrhotite. It may be noted that limonite in an outcrop 1,200 feet northerly from the centre of principal outcrop was seen to be derived from pyrite, but that elsewhere pyrrhotite appears to have been the source of the limonite. Samples of limonitic material may, like samples of clean magnetite, be high in iron, but they contain more sulphur than the clean magnetite. It may be noted that, as the minerals magnetite,[*] limonite,[†] and pyrrhotite[‡] all have a high content of iron, samples consisting principally of these minerals, regardless of their proportion, will be high in iron. However, magnetite ore containing pyrrhotite would be undesirable because of the high sulphur content.

With the exception of one outcrop of better than average magnetite, all the smaller outcrops seen by the writer, which include the four outcrops seen in the Fault Creek basin, displayed patches of rust and some a boxwork or network of limonite ribs in magnetite throughout the whole outcrop area. The best outcrop of magnetite, i.e., the outcrop containing least limonite, is an outcrop 50 feet in diameter in the rocky walls of a tributary of Fault Creek 1,200 feet north 20 degrees east from the centre of the principal outcrop shown in Figure 39. In this outcrop an area 6 feet wide by 15 feet long contained only one small patch of limonite a few inches in diameter. However, the southwestern corner of the outcrop is covered by an area of limonite 20 feet in diameter.

---

[*] **Magnetite:** Iron, 72.4 per cent.; oxygen, 27.6 per cent.

[†] **Limonite:** Iron, 59.8 per cent.; oxygen, 25.7 per cent.; water, 14.5 per cent.

[‡] **Pyrrhotite:** Iron, 60.4 per cent.; sulphur, 39.6 per cent.

Samples of different types of mineralization were taken from sample pits in the largest outcrop and the assays of these are given in the following table:—

	1.	2.	3.	4.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Iron (Fe)	68.41	64.29	68.68	67.04
Titania (TiO_2)	0.017	0.016	0.003	0.006
Sulphur (S)	1.10	10.0	10.5	2.6
Phosphorus (P)	0.015	0.021	0.006	0.013
Silica (SiO_2)	2.08	2.66	0.82	1.04
Copper (Cu)	Trace	0.77	0.09	0.09

1. Across 24 inches of relatively pure magnetite, containing no pyrrhotite or limonite.
2. Across 18 inches of unoxidized magnetite and pyrrhotite.
3. Across 12 inches of unoxidized magnetite and pyrrhotite.
4. Across 14 inches of alternating layers of limonite and limonite plus magnetite.

Gold-Silver-Lead Vein.—This vein cuts the limestone 250 to 450 feet southeasterly from the magnetite-pyrrhotite bodies but has no structural or mineralogical connection with them (Fig. 39).

The vein shear had been exposed by several pits, in a length of about 170 feet, at the time of the writer's visit, and two diamond-drill holes had been drilled towards the shear. However, the results of the drilling were inconclusive because of caving ground and difficulties in coring.

The shear, strike north 25 degrees west, and dip 60 degrees southwest, has been offset a few feet by each of three westerly striking, vertical cross-faults, so that the resultant trend of the shear over the length of 170 feet is about north 45 degrees west.

The shear zone ranges in width from a knife-edge to 5 feet but maintains widths of 6 to 30 inches for considerable lengths. It contains, in addition to sheared wallrock, short lenses, up to 1 foot thick, of comb quartz containing abundant arsenopyrite and smaller amounts of cube galena, sphalerite, and pyrite. The sulphide vein matter contains appreciable amounts of gold and silver and assays of selected samples of such material are given in the following table:—

	Gold.	Silver.	Copper.	Lead.	Zinc.
	Oz. per Ton.	Oz. per Ton.	Per Cent.	Per Cent.	Per Cent.
1.	0.44	0.6	0.04	0.23	Trace
2.	3.16	7.5	0.07	10.60	Trace
3.	1.49	4.8	0.24	7.98	0.7

Much higher assays in silver and lead have been reported from selected samples containing abundant galena.

Cavalier. Several small bodies of magnetite are found immediately south of the Churchill group on ground formerly covered by the surveyed mineral claims Cavalier Nos. 2 and 4, which have lapsed. This magnetite is close to the trail between 1,000 and 1,500 feet north of the Churchill cabin and has been exposed by open-cuts. The magnetite lies between diorite on the west and limestone on the east and is along the same diorite-limestone contact as are the Churchill showings, but a considerable distance south of them. It also contains considerable pyrrhotite mixed with the magnetite.

At elevation 2,170 feet a stripping on the west side of the trail exposes a lens of magnetite 6 feet in diameter and 1 to 2 feet thick.

At elevation 1,880 feet, on the northwest side of the trail, a cut driven 8 feet northeasterly was partly sloughed, and no magnetite was found in place, but magnetite piled at the mouth indicated that some had been found in the cut. At the same elevation but 14 feet easterly along the hillside, an open-cut driven about 10 feet northeasterly crosses two lenses of magnetite, strike northwesterly and dip 60 degrees southwestward, a lens at the portal, 2 inches thick, and one near the face, 12 inches thick.

A third cut 72 feet northeasterly along the hillside from the second that has been driven 15 feet northeasterly into the hillside exposes 5 feet of magnetite at the face.

PROPERTIES ON TRIBUTARIES OF THE LITTLE ZEBALLOS RIVER.

Beano. The Beano group, at the south edge of the map sheet (Fig. 2), is reported to include the Beano No. 1 (L. 509), Freake Nos. 1 and 2 (Lots 521 and 522), Wedge (L. 512), and Wedge Fraction (L. 511) Mineral Claims, staked in 1944 by V. D. Davies and held by record by Mr. Davies. No production has been reported from the property.

The showings are on Bingo (Beano) Creek. A tractor-road runs from the beach at the mouth of the Little Zeballos River to ore-bunkers 3 miles distant at an elevation of 1,225 feet; from the bunkers about 1,000 feet of good trail leads to the camp, elevation 1,470 feet. The property may also be reached by a steep foot-trail, 1¼ miles long, that leads over a hump, elevation 460 feet, east of Zeballos town and joins the tractor-road about 1¼ miles below the camp. The main workings, elevation 2,610 feet, are reached from the camp by a very steep foot-trail, about 2,000 feet long. At the time of the writer's visit in 1946 an aerial tram-line, about 3,000 feet long, was being built to connect the ore-bunkers with the main workings.

The ground was first staked in 1936 and 1937 by Alex Stewart and A. Trout. In 1938 A. Trout and H. Davis, of Vancouver, held an option on the property and that same year turned the option over to A. Freake and associates, of Toronto, who in 1938 and 1939 did the first extensive work on the property. They built the trail over the hump from Zeballos, built shake cabins on the property, and did a small amount of surface stripping on both the upper showings and the canyon showings. In 1939 Freake and his associates are reported to have relinquished the property to the Victory Mining Syndicate, of Seattle. This syndicate organized Victory Mining Company, Limited, and in 1943 and 1945 the company built 4 miles of tractor-road from the beach at the mouth of the Little Zeballos, erected ore-bunkers at the end of the road, and in the winter of 1945–46 built 3,000 feet of aerial tram-line from the ore-bunkers to the upper workings. It is understood that a small amount of work was done during 1947 and 1948 by Mr. Davies.

The showings developed by workings are in the canyon of Bingo Creek (Fig. 40) and on the rim immediately above the canyon (Fig. 41). They consist of a zone of quartz-calcite-pyrrhotite stringers in actinolite rock and of grains and masses of pyrrhotite without the quartz and calcite, also in actinolite rock. The pyrrhotite usually contains a small amount of chalcopyrite. The actinolite rock is dark green and massive and consists of felted actinolite crystals with disseminated pyrrhotite grains between them. Some of the actinolite rock is relatively fine grained with crystals one-sixteenth of an inch long and some of it is coarse grained with crystals up to 2 inches long. A sample of fine-grained actinolite and one of coarse-grained assayed: Gold, 0.01 ounce per ton; silver, *nil*.

The actinolite rock represents the alteration of limestone that lies between two beds of andesitic tuff. In some places all the limestone has been replaced, and in others a considerable amount still remains in the footwall of the actinolite rock. The limestone appears to have been about 30 feet thick.

The strike of the rocks is northerly and the dip steeply eastward.

The workings in the canyon (Fig. 40) consist of two short adits and two open-cuts that have been driven in the west wall of the canyon across a zone of quartz-calcite-pyrrhotite stringers and lenses up to 3 feet thick that follow the formation.

The southern adit, about 30 feet above the creek bed, has been driven westerly for 8 feet. Most of the adit is in actinolite rock, but, about 4 feet from the portal, lime-

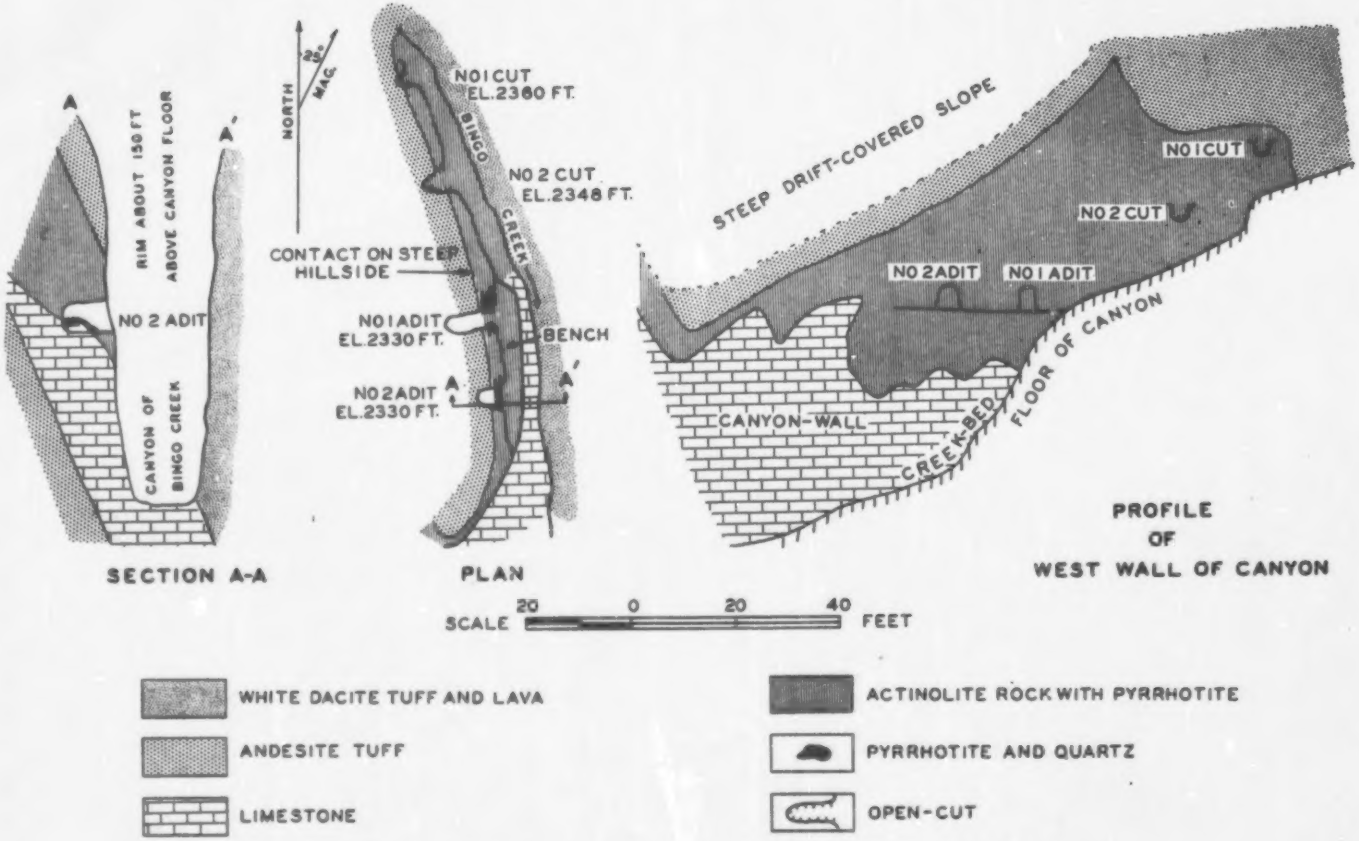
SECTION A-A
A
A'
RIM ABOUT 150 FT ABOVE CANYON FLOOR
NO 2 ADIT
CANYON OF BINGO CREEK
NORTH
MAG.
25°
PLAN
NO I CUT EL.2360 FT.
NO 2 CUT EL.2348 FT.
BINGO CREEK
CONTACT ON STEEP HILLSIDE
NO I ADIT EL.2330 FT.
NO 2 ADIT EL.2330 FT.
BENCH
PROFILE OF WEST WALL OF CANYON
STEEP DRIFT-COVERED SLOPE
NO I CUT
NO 2 CUT
NO 2 ADIT
NO I ADIT
FLOOR OF CANYON
CREEK-BED
CANYON-WALL
SCALE 20 0 20 40 FEET
WHITE DACITE TUFF AND LAVA
ANDESITE TUFF
LIMESTONE
ACTINOLITE ROCK WITH PYRRHOTITE
PYRRHOTITE AND QUARTZ
OPEN-CUT

Fig. 40. Beano: Plan, cross-section, and profile of lower or canyon workings.

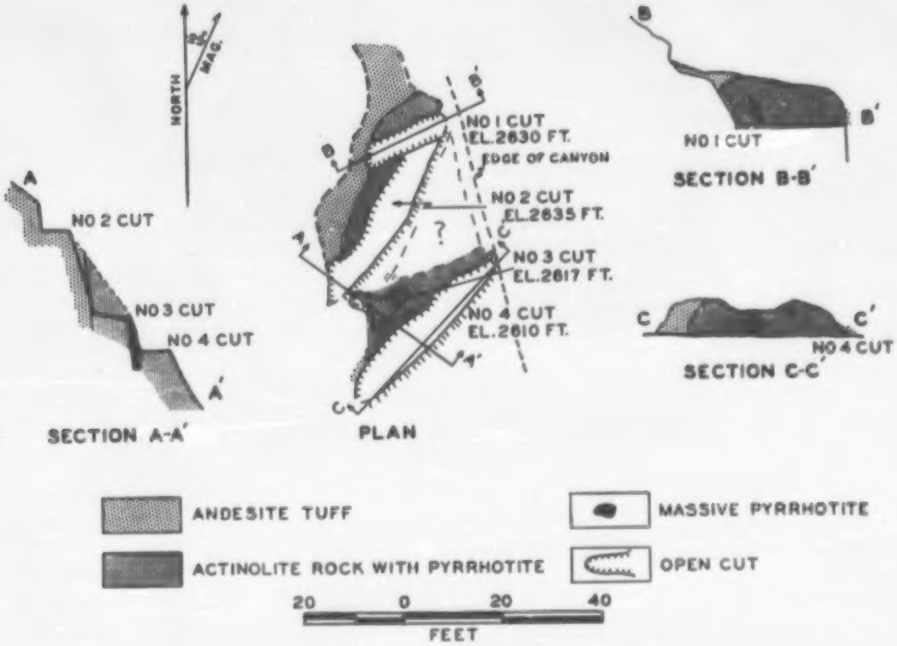
NORTH
MAG.
25°
A
NO 2 CUT
NO 3 CUT
NO 4 CUT
A'
SECTION A-A'
B
B'
NO I CUT
EL.2630 FT.
EDGE OF CANYON
NO 2 CUT
EL.2635 FT.
?
C
NO 3 CUT
EL.2617 FT.
A
NO 4 CUT
EL.2610 FT.
A'
C'
PLAN
B
B'
NO I CUT
SECTION B-B'
C
C'
NO 4 CUT
SECTION C-C'
ANDESITE TUFF
ACTINOLITE ROCK WITH PYRRHOTITE
MASSIVE PYRRHOTITE
OPEN CUT
20
0
20
40
FEET

Fig. 41. Beano: Plan and sections of upper workings.

stone is found in the floor and rises half-way up the walls as the face is approached. Small masses of pyrrhotite, about a foot thick by 4 feet long, are found between the limestone and the actinolite rock. A sample, taken across 1 foot of massive pyrrhotite, assayed: Gold, 0.18 ounce per ton; silver, *nil*.

The northern adit, 6 feet above the creek bed, has been driven 7 feet through actinolite rock and then 4 feet through andesite. On the north wall of the adit at the portal a lens of pyrrhotite, quartz, and calcite 3 feet wide is found in the actinolite rock. This material extends along the canyon wall northerly for 6 feet, and stringers of pyrrhotite, quartz, and calcite a few inches wide extend southerly across the adit and along the canyon wall to the north wall of the southern adit.

The open-cuts are entirely in actinolite rock and do not crosscut any of the mineralized material that was found in the two adits. The mineralization appears to have petered out northerly from the adits.

The upper workings (Fig. 41), on the rim of the canyon above the lower showings, consist of open-cuts in a body of actinolite rock that contains disseminated pyrrhotite and some bodies of massive pyrrhotite. The mass of actinolite rock is lenticular and in the workings ranges in thickness from 20 to 30 feet. It appears to trend northerly and to dip steeply eastward. It lies between beds of andesite tuff and, as inferred from its occurrence in the canyon below, appears to be a replacement of limestone.

No. 1 cut has been driven across the actinolite rock and cuts a streak of pyrrhotite about 6 inches thick by 3 feet long.

No. 2, a combined stripping and cut 4 feet above the floor of No. 1 cut, extends along the face of the outcrop diagonally across the actinolite rock, which contains a moderate amount of disseminated pyrrhotite but no massive lenses of the sulphide. A sample of actinolite containing pyrrhotite, taken by Maconachie (1938, p. F 42) across the west end of this cut, assayed: Gold 2.76 ounces per ton; silver, trace; nickel, *nil;* platinum, *nil.*

No. 3 cut is in similar material.

No. 4 cut is in actinolite rock with disseminated pyrrhotite and exposes a lens of of massive pyrrhotite 2 feet thick by 4 feet high. A sample taken across the massive pyrrhotite of this lens assayed: Gold, 6.06 ounces per ton; silver, 3.04 ounces per ton. A sample of similar material taken from the dump assayed: Gold, 3.04 ounces per ton; silver, *nil.*

Four samples taken by Maconachie (1938, p. F 42) across the face of No. 4 cut assayed as follows:—

No. 1.—At 3 feet from west end of the bench, across 50 inches . . . little visible mineral: Gold, 0.80 oz. per ton; silver, *nil;* nickel, *nil;* platinum, *nil.*

No. 2.—At 9 feet from west end of bench, across 28 inches . . . containing one section of abundant pyrrhotite: Gold, 1.60 oz. per ton; silver, 0.2 oz. per ton; nickel, *nil;* platinum, *nil.*

No. 3.—At 15 feet from west end of bench, across 10 inches . . . including 5 inches of almost solid pyrrhotite: Gold, 3.50 oz. per ton; silver, 0.1 oz. per ton; nickel, *nil;* platinum, *nil.*

No. 4.—A sample of massive pyrrhotite assayed: Gold, 9.38 oz. per ton; silver, 0.2 oz. per ton.

Friend.

The Friend property, on Friend Creek about half a mile south of the south edge of the map-area, is reported to consist of the Friend Nos. 1 to 8 Mineral Claims, staked in September, 1937, by Alex L. Stewart, C. W. Smith, and A. M. McDonald, and owned by L. B. Brown, Owen C. Anderson, and A. M. McDonald, of Zeballos.

The property was staked in the autumn of 1937 when the Zeballos area was being prospected very actively. Early in 1938 the property was optioned to Pioneer Gold Mines of B.C., Limited. This company did some surface work and drove two short adits on the property, one on an intermediate vein near the camp (*see* Fig. 42) and the other on an upper vein (*see* Fig. 43). It is reported that this company ceased work on the property in 1940. Between 1940 and 1946 further prospecting was done by the owners. In 1946 the property was optioned to George Sinclair, Vince Clayton, and associates, who, during the summer of 1946, drove a new adit 60 feet below the adit on the intermediate vein, but later in the year they dropped their option. Little further work has been done on the property, and no production has been reported.

The claims extend, two deep, for about 6,000 feet up Friend Creek from near its junction with Little Zeballos River. The camp, consisting of one large and two smaller cabins, is on the west bank of Friend Creek, at elevation 1,150 feet, and may be reached by 3 miles of trail from the town of Zeballos or by 1¾ miles of tractor-road and 1 mile of horse-trail from the beach at the mouth of the Little Zeballos River.

The hillside near the workings rises steeply from the rocky floor of Friend Creek in rock bluffs and steep, wooded slopes. A heavy stand of timber, consisting mainly of hemlock and fir, covers most of the property.

The rocks exposed in the canyon of Friend Creek between the lowest and highest showings include northwesterly striking, southwestward dipping green andesite tuff with interbedded lenses of limestone, white dacite tuff, and a small amount of gabbro. At the highest showings the andesite tuff contains diorite in patches from a few inches to several feet in diameter that merge mineralogically and texturally with enclosing tuff. In this same place the rock has been cut by a 15-foot feldspar porphyry dyke, strike north 25 degrees west and dip vertical.

Three main veins have been developed on the property, and it is reported that several other small veins have been found. The three main veins outcrop in the bed and rocky walls of Friend Creek—the lowest is downstream from camp at an elevation of 870 feet; the intermediate, close to camp, at an elevation of 1,180 feet (Fig. 42); and the highest, upstream from camp, at an elevation of 1,610 feet (Fig. 43).

The lowest vein has been exposed for 30 feet along the base of a rock bluff that forms the east wall of the creek at elevation 870 feet. The vein follows a shear, 6 inches to 2 feet wide, that strikes north 10 to 20 degrees west and dips 70 degrees eastward and contains quartz ranging in width from 1½ to 4 inches, which widens where the shear bends to a strike of north 20 degrees west for a short distance and narrows where the strike is north 10 degrees west. The quartz contains patches of calcite and ribbons of fine arsenopyrite but no other sulphide. Samples taken from the quartz vein were as follows: North end, 4 inches wide—gold, 0.14 ounce per ton; silver, 0.1 ounce per ton; middle, 4 inches wide—gold, 0.18 ounce per ton; silver, 0.1 ounce per ton; south end, 4 inches wide—gold, 0.05 ounce per ton; silver, 0.1 ounce per ton. The rock, from 100 feet upstream to an unknown distance downstream from this showing, is coarse-grained gabbro. Northwesterly striking tuff is found upstream from the gabbro.

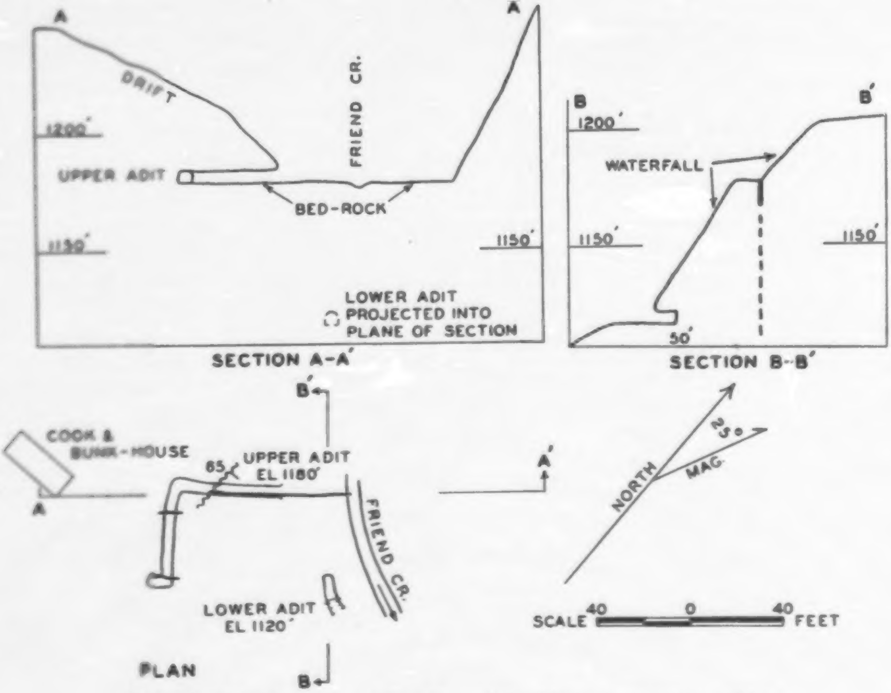
A
A'
DRIFT
FRIEND CR.
1200'
UPPER ADIT
BED-ROCK
1130'
1150'
LOWER ADIT PROJECTED INTO PLANE OF SECTION
SECTION A-A'
B
B'
1200'
WATERFALL
1150'
1150'
50'
SECTION B-B'
B'
COOK & BUNK-HOUSE
65
UPPER ADIT EL 1180'
A
A'
FRIEND CR.
LOWER ADIT EL 1120'
PLAN
B
NORTH
MAG.
25°
SCALE 40 0 40 FEET

Fig. 42. Friend: Plan and section of workings, near camp cabins, on the intermediate vein.

The intermediate vein, which strikes north 50 degrees east and is vertical, outcrops part way down a waterfall near camp and has been developed by two adits (Fig. 42). The vein consists of 1 to 3 inches of vuggy quartz frozen to the walls and is mineralized with fine arsenopyrite and small amounts of pyrrhotite, chalcopyrite, and sphalerite. Bancroft (1940, p. 37) reports visible gold in this vein. Southwesterly, the quartz narrows to half an inch in the drift and at 30 feet from the portal has been cut off by a slip. Two 1-inch quartz stringers were found in the crosscut, and it is possible that the northwestern stringer, which contains a little pyrite and arsenopyrite, is the continuation of the main quartz vein. Northeasterly the quartz dies out in a narrow shear that joins a strong northerly striking shear zone about 50 feet northeast of the creek bed. This shear zone is on the strike of the lowest vein and accompanying shear and may be the northerly continuation of that shear. The main vein in the adit, possessing the vugginess and tightness of a gash vein, may be a tension opening related to movement along the northerly striking shear.

The lower adit, driven to crosscut the main vein 60 feet below the upper adit, had just been started when the property was examined in September, 1946. Since then the vein was intersected and the vein matter reported to be comparable to that in the creek bed above.

The rock in the adits near the camp is massive, dark-green andesite tuff with small lenses of limestone found interbedded with 8-inch beds of andesite tuff 100 feet upstream from the waterfall. The beds strike northwesterly and dip 50 degrees southwestward. The quartz vein, strike north 50 degrees east and dip vertical, in these adits is therefore transverse to the bedding of the andesite tuff and limestone.

Assays of samples from this vein are given in an earlier description of the property by Maconachie (1938, p. F 46) and for completeness are included with those of the present writer, as follows:—

Location of Sample.	Width.	Gold.	Silver.	Reference.
	Inches.	Oz. per Ton.	Oz. per Ton.	
Creek exposure	3	6.10	1.0	Maconachie, p. F 46
Creek bed, 30 feet northeast of portal	3	2.65	0.5	....
Creek bed, 15 feet northeast of portal	3	1.20	Trace	....
Vein just northeast of fault	2	4.60	0.5	Maconachie, p. F 46
Creek exposure specimens of high grade	....	8.35	0.7	....

The highest showing is a quartz vein exposed on both sides of the creek, at an elevation of 1,610 feet, about 2,500 feet upstream from the main cabin. It has been developed by an adit on the east side of the creek and by a shorter adit and several open-cuts on the west side of the creek (Fig. 43).

The vein, as seen in the main adit, is a silicified zone a few inches to 5 feet wide that has been cut by later stringers of quartz, pyrite, and arsenopyrite, and by short lenses of quartz and pyrrhotite.

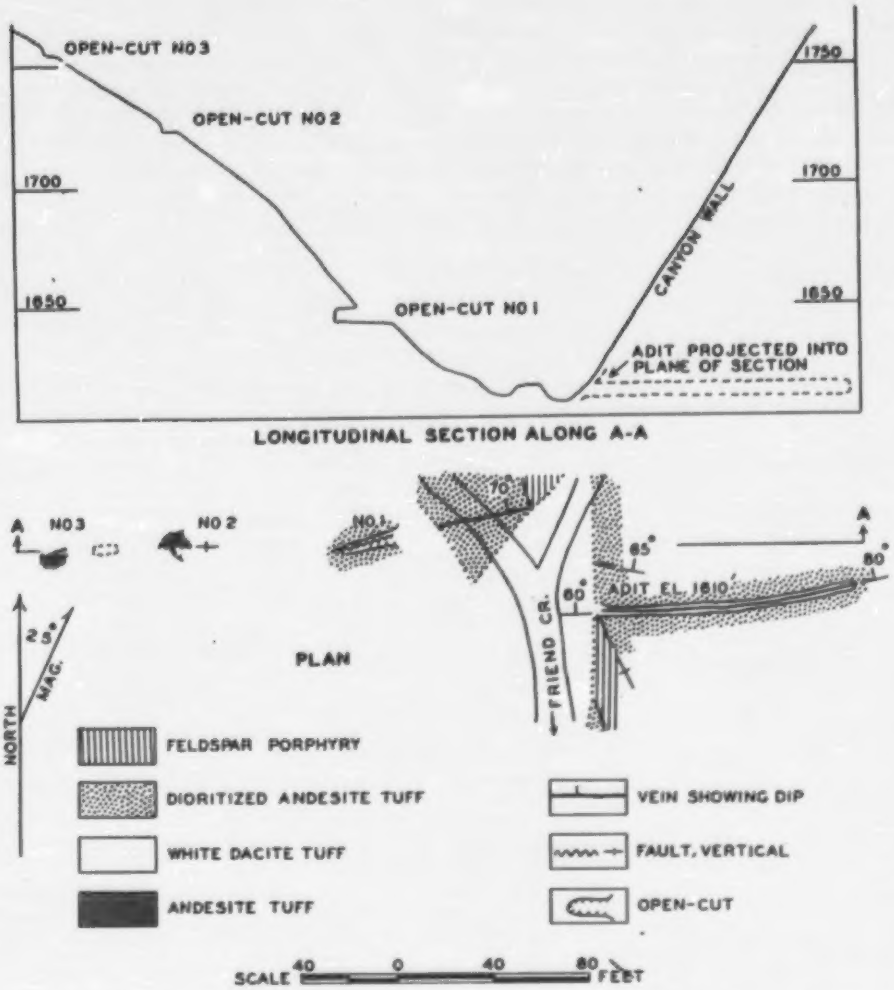
OPEN-CUT NO 3
OPEN-CUT NO 2
OPEN-CUT NO 1
1750
1700
1650
1700
1650
CANYON WALL
ADIT PROJECTED INTO PLANE OF SECTION
LONGITUDINAL SECTION ALONG A-A
A
NO 3
NO 2
NO 1
70°
65°
A
80°
60°
ADIT EL. 1810'
FRIEND CR.
PLAN
NORTH
25°
MAG.
FELDSPAR PORPHYRY
DIORITIZED ANDESITE TUFF
WHITE DACITE TUFF
ANDESITE TUFF
VEIN SHOWING DIP
FAULT, VERTICAL
OPEN-CUT
SCALE 40 0 40 80 FEET

Fig. 43. Friend: Plan and longitudinal section of workings on the upper vein.

Assays of samples taken of the vein matter in the adit are as follows:—

Location.	Description.	Width.	Gold.	Silver.
		Inches.	Oz. per Ton.	Oz. per Ton.
Above cap	Silicified zone, including a 2-inch pocket of pyrite	18	0.22	0.7
Portal plus 24 feet	Footwall stringer of quartz and heavy pyrite	1	1.09	1.4
Portal plus 35 feet	Full width of silicified zone, contains scattered pyrite and pyrrhotite	30	*Nil*	0.8
Portal plus 48 feet	Lens of quartz and abundant pyrrhotite, crossing from middle to hangingwall of vein, 8 feet long and up to 1 foot wide	....	0.25	1.0
Portal plus 60 feet	Lens of pyrrhotite in hangingwall, 2 feet long by 2 inches wide	....	0.02	0.5

A few feet west of the portal the westerly continuation of the vein has been faulted 50 feet to the north along a northerly striking fault. This fault, consisting of several inches of crushed rock, is seen about 60 feet upstream from the adit where the steep wall of the canyon forms the east wall of the fault. The fault also displaces the feldspar porphyry dyke a similar amount in the same direction.

The vein is exposed for 40 feet in the creek bed west of the dyke, where it is seen to consist of a leached zone 3 feet wide cut by stringers of quartz and pyrite. Two samples taken across this zone assayed trace and 0.03 ounce in gold respectively.

Silicification and mineralization die out westerly from the showing in the creek. In the short adit only a small amount of silicification is found, and in the open-cuts farther westerly up the hillside silicification is absent, and only rusty sheared rock is found on strike. A sample of this rusty sheared rock assayed only a trace in gold.

A second vein is found 20 feet north of the portal of the main adit, but no work has been done on it. This vein consists of 4 to 6 inches of quartz mineralized with pyrite. A sample taken across the full width of the vein assayed: Gold, 0.02 ounce per ton; silver, 0.8 ounce per ton.

A lens of quartz, 12 feet long by 6 inches to 1 foot thick, is found about 1,500 feet along the trail from the main camp towards the upper workings. This quartz lens is a silicified replacement of slightly sheared andesite. Two samples of the silicified material assayed *nil* and trace in gold.

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1950.

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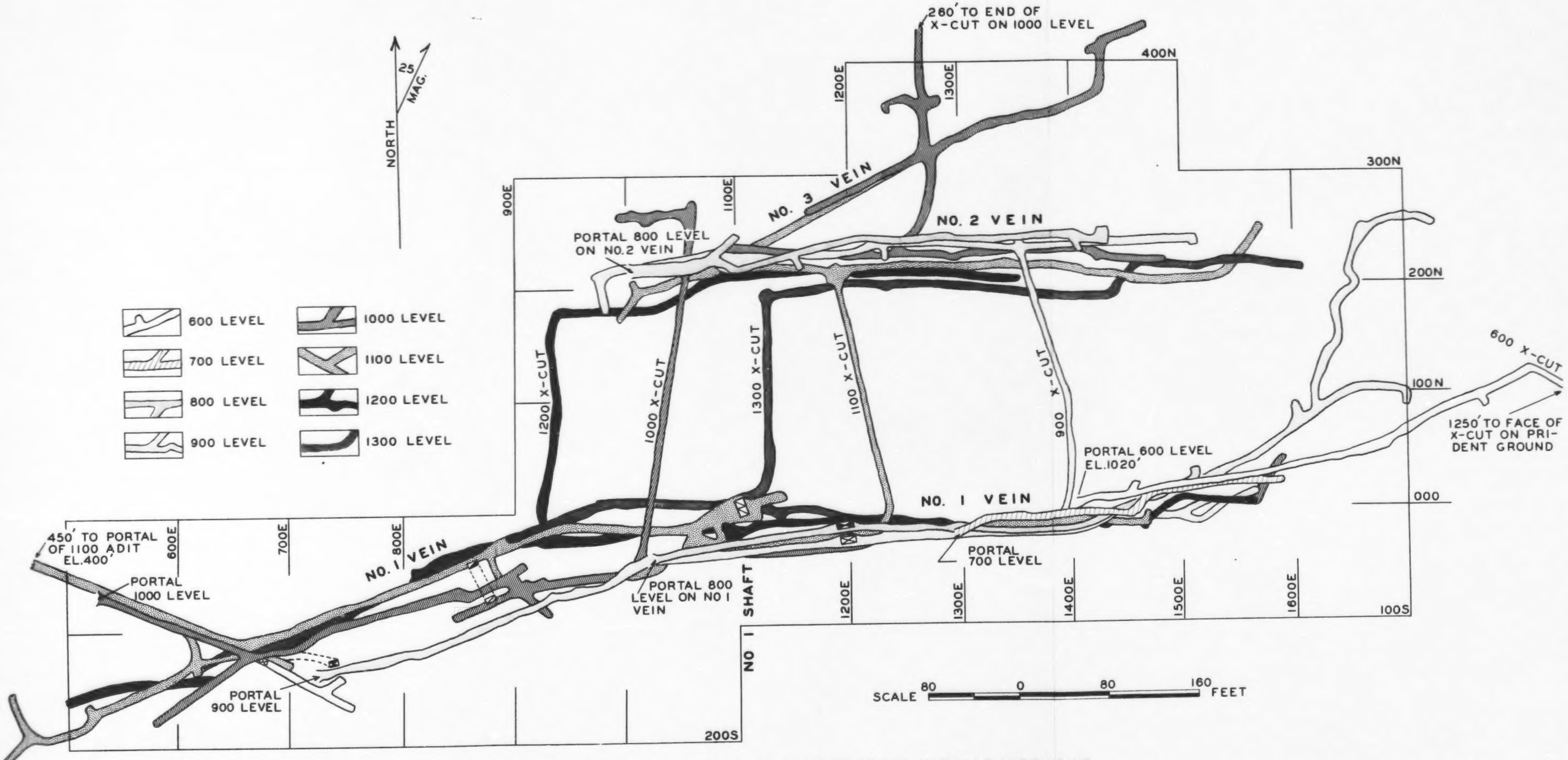

NORTH
25
MAG.
260' TO END OF X-CUT ON 1000 LEVEL
400N
300N
200N
100N
000
100S
200S
900E
1100E
1200E
1300E
1400E
1500E
1600E
600E
700E
800E
NO. 3 VEIN
NO. 2 VEIN
NO. 1 VEIN
PORTAL 800 LEVEL ON NO.2 VEIN
600 LEVEL
700 LEVEL
800 LEVEL
900 LEVEL
1000 LEVEL
1100 LEVEL
1200 LEVEL
1300 LEVEL
1200 X-CUT
1000 X-CUT
1300 X-CUT
1100 X-CUT
900 X-CUT
600 X-CUT
1250' TO FACE OF X-CUT ON PRIDENT GROUND
PORTAL 600 LEVEL EL.1020'
PORTAL 700 LEVEL
PORTAL 800 LEVEL ON NO I VEIN
NO I SHAFT
450' TO PORTAL OF 1100 ADIT EL.400'
PORTAL 1000 LEVEL
PORTAL 900 LEVEL
SCALE 80 0 80 160 FEET

FIG. 7. PRIVATEER. COMPOSITE PLAN SHOWING DRIFTS ON NOs. 1, 2, AND 3 VEINS.

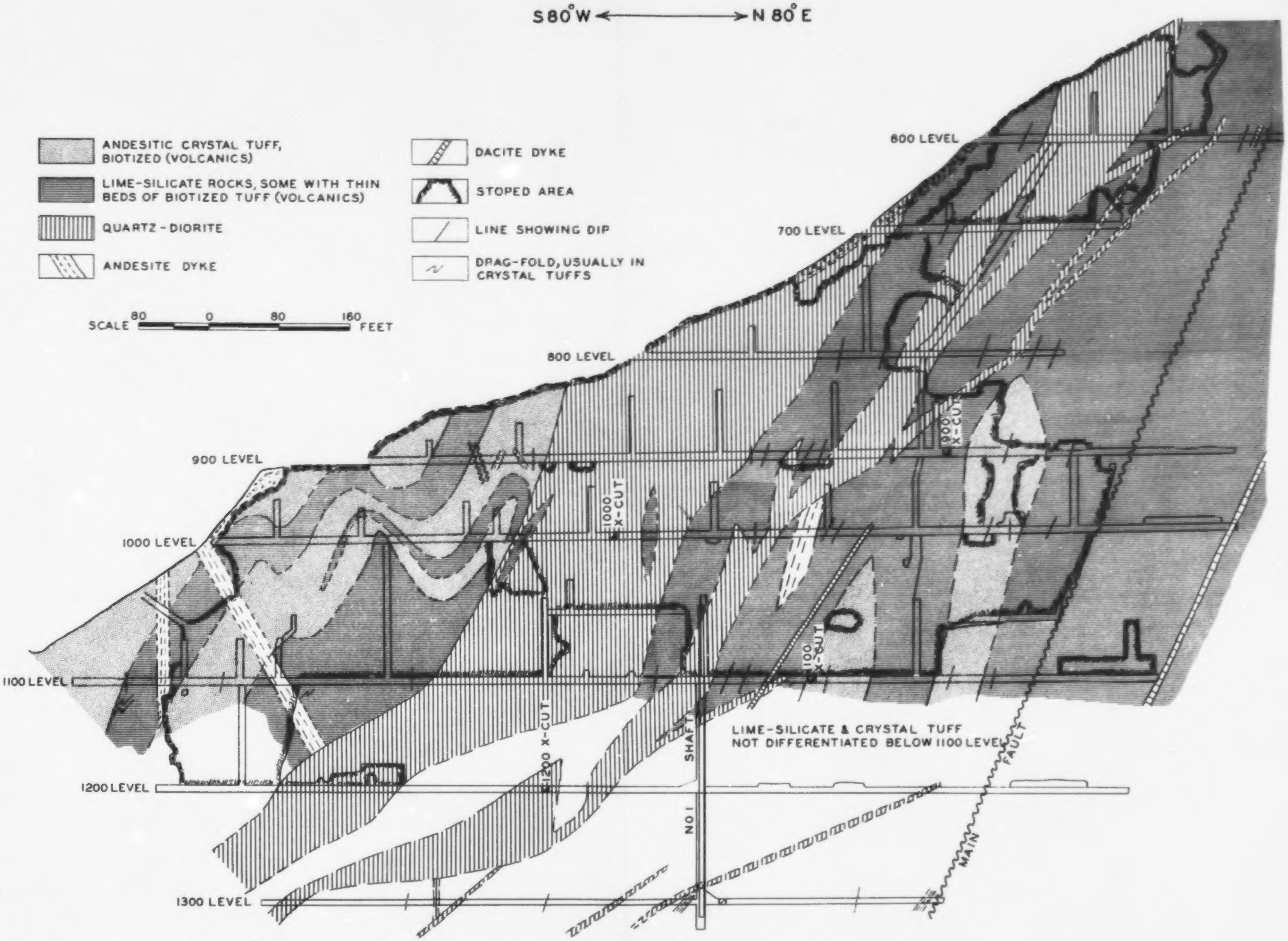

S80°W ⟵⟶ N 80°E
ANDESITIC CRYSTAL TUFF, BIOTIZED (VOLCANICS)
LIME-SILICATE ROCKS, SOME WITH THIN BEDS OF BIOTIZED TUFF (VOLCANICS)
QUARTZ-DIORITE
ANDESITE DYKE
DACITE DYKE
STOPED AREA
LINE SHOWING DIP
DRAG-FOLD, USUALLY IN CRYSTAL TUFFS
SCALE 80 0 80 160 FEET
600 LEVEL
700 LEVEL
800 LEVEL
900 LEVEL
1000 LEVEL
1100 LEVEL
1200 LEVEL
1300 LEVEL
900 X-CUT
1000 X-CUT
1100 X-CUT
1200 X-CUT
NO 1 SHAFT
LIME-SILICATE & CRYSTAL TUFF NOT DIFFERENTIATED BELOW 1100 LEVEL
MAIN FAULT

FIG. 10. PRIVATEER. LONGITUDINAL PROJECTION ON NO. 1 VEIN

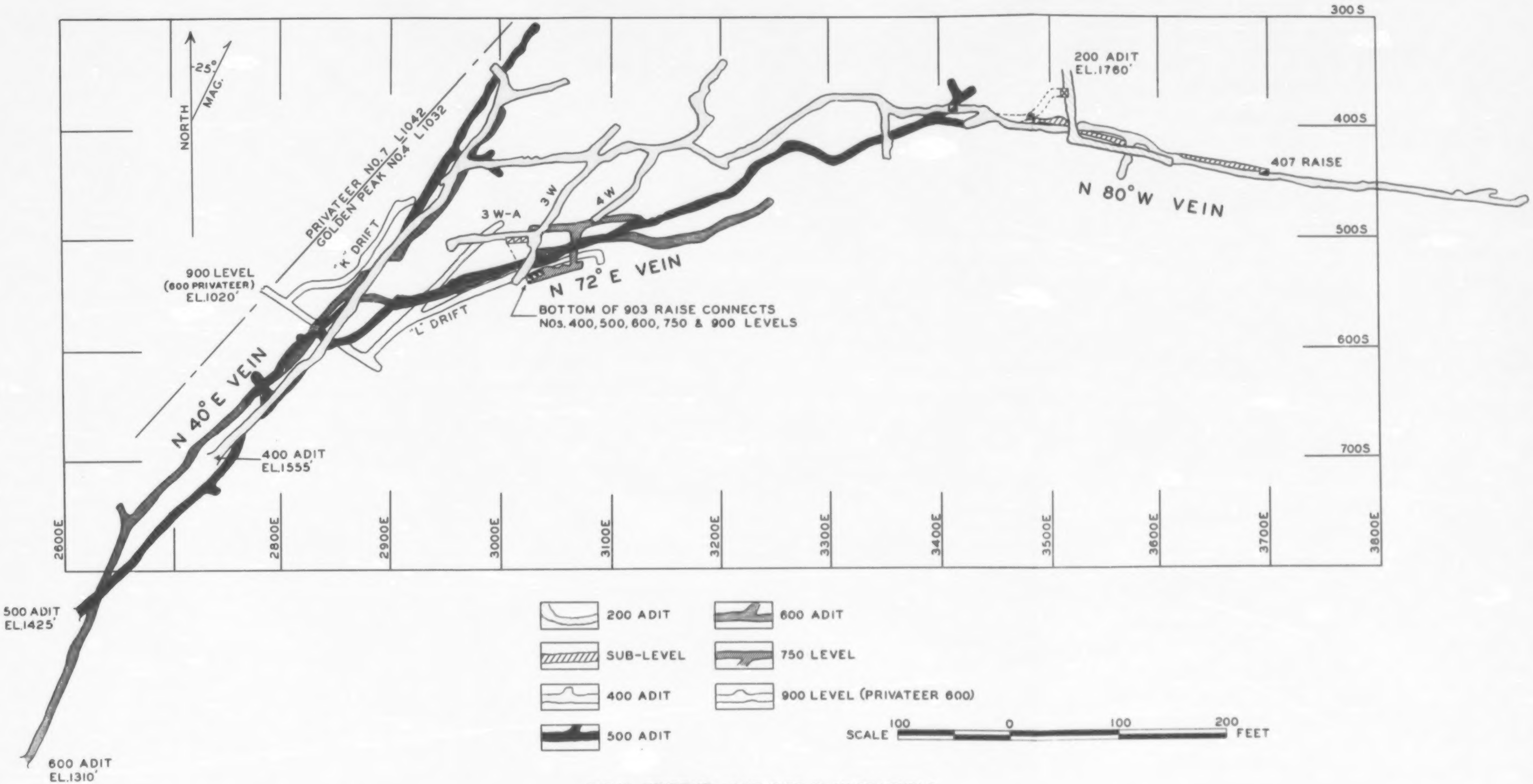
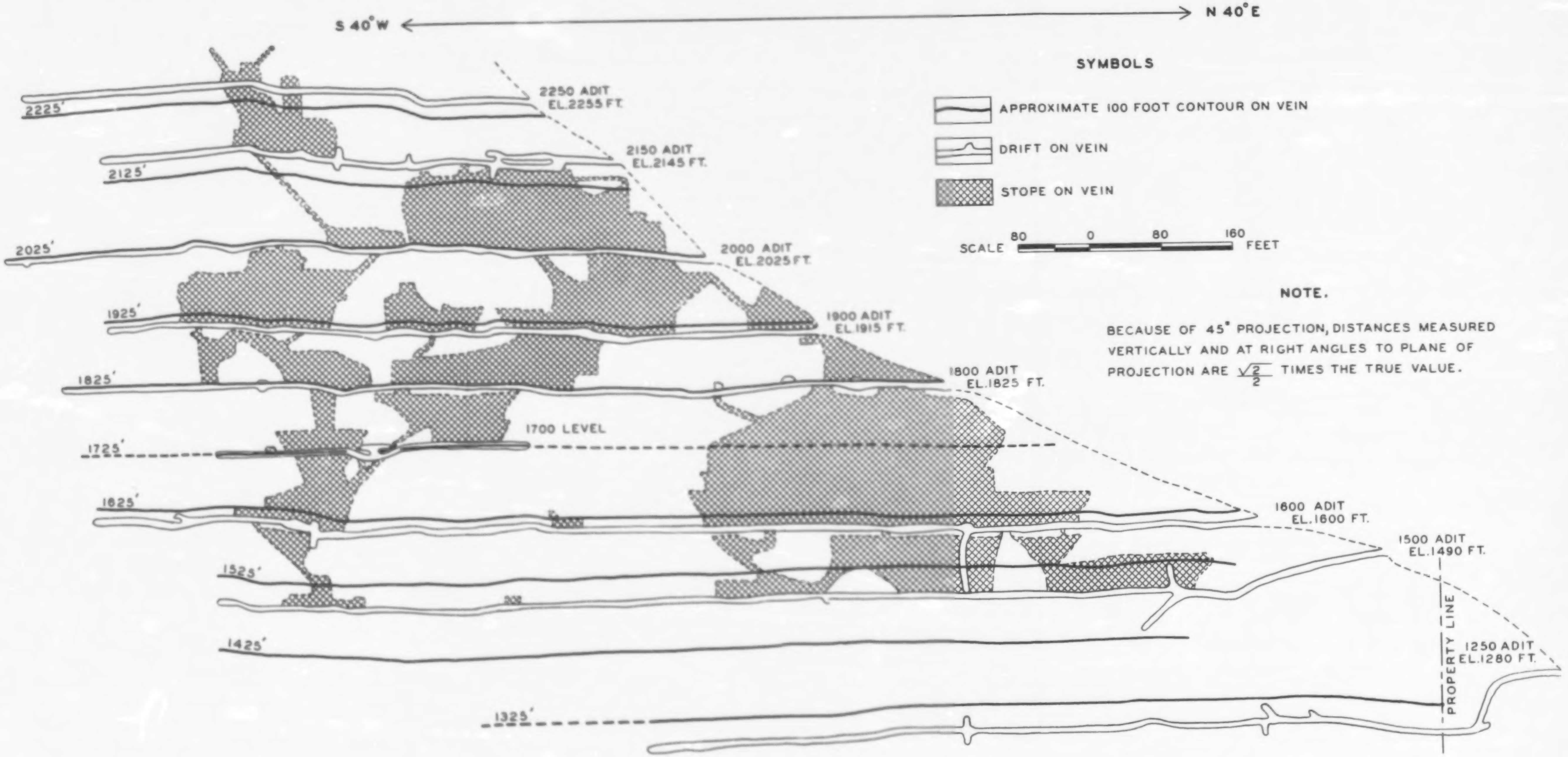

NORTH
25°
MAG.
PRIVATEER NO.7 L.1042
GOLDEN PEAK NO.4 L.1032
900 LEVEL
(600 PRIVATEER)
EL.1020'
"K" DRIFT
"L" DRIFT
3 W-A
3 W
4 W
N 72° E VEIN
N 40° E VEIN
N 80° W VEIN
BOTTOM OF 903 RAISE CONNECTS
NOs. 400, 500, 600, 750 & 900 LEVELS
200 ADIT
EL.1760'
407 RAISE
400 ADIT
EL.1555'
500 ADIT
EL.1425'
600 ADIT
EL.1310'
300 S
400 S
500 S
600 S
700 S
2600E
2800E
2900E
3000E
3100E
3200E
3300E
3400E
3500E
3600E
3700E
3800E
200 ADIT
SUB-LEVEL
400 ADIT
500 ADIT
600 ADIT
750 LEVEL
900 LEVEL (PRIVATEER 600)
SCALE
100
0
100
200
FEET

FIG 13. PRIDENT. COMPOSITE PLAN OF LEVELS.


S 40°W
N 40°E
SYMBOLS
APPROXIMATE 100 FOOT CONTOUR ON VEIN
DRIFT ON VEIN
STOPE ON VEIN
SCALE 80 0 80 160 FEET
2225'
2250 ADIT EL.2255 FT.
2125'
2150 ADIT EL.2145 FT.
2025'
2000 ADIT EL.2025 FT.
1925'
1900 ADIT EL.1915 FT.
1825'
1800 ADIT EL.1825 FT.
1725'
1700 LEVEL
1625'
1600 ADIT EL.1600 FT.
1525'
1500 ADIT EL.1490 FT.
1425'
1325'
1250 ADIT EL.1280 FT.
PROPERTY LINE

NOTE.

BECAUSE OF 45° PROJECTION, DISTANCES MEASURED VERTICALLY AND AT RIGHT ANGLES TO PLANE OF PROJECTION ARE $\frac{\sqrt{2}}{2}$ TIMES THE TRUE VALUE.

FIG. 21. MOUNT ZEBALLOS. WORKINGS ON THE MOUNT ZEBALLOS VEIN PROJECTED ONTO A PLANE DIPPING 45° S.E.

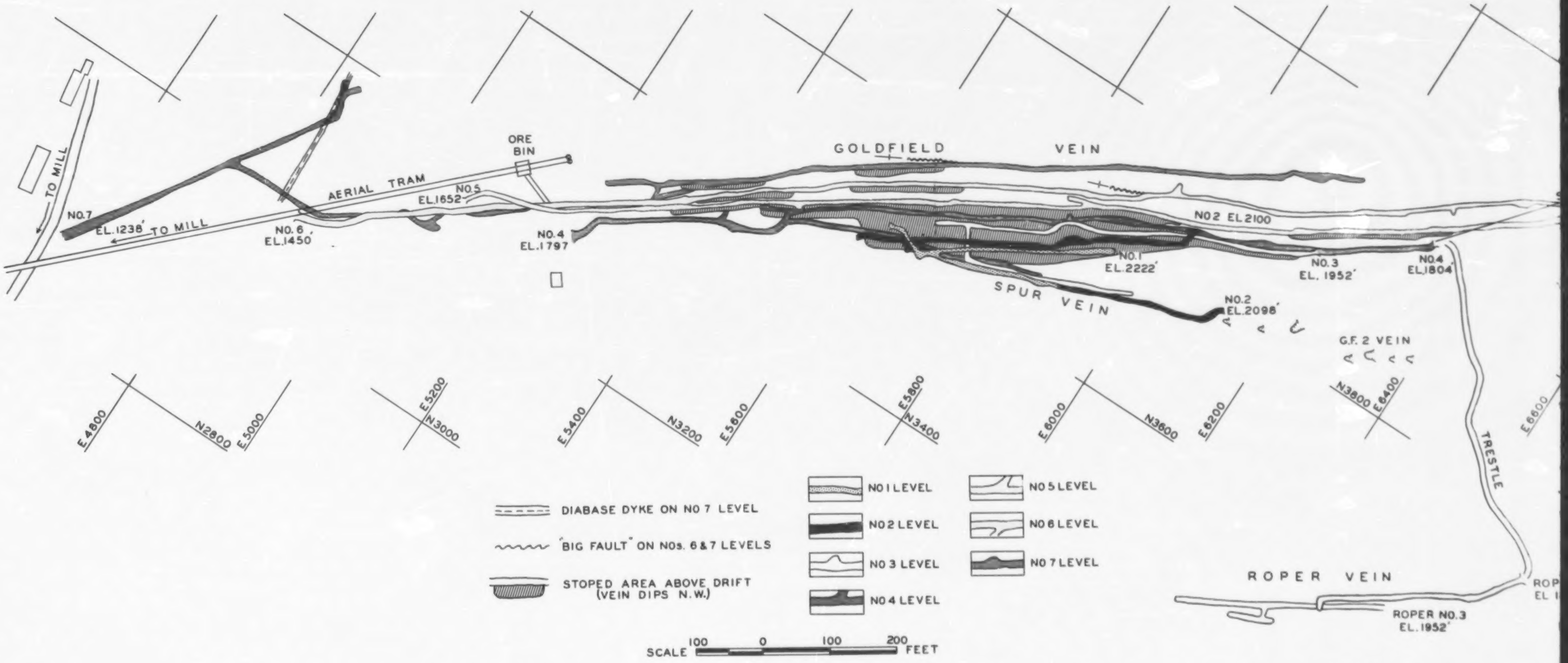
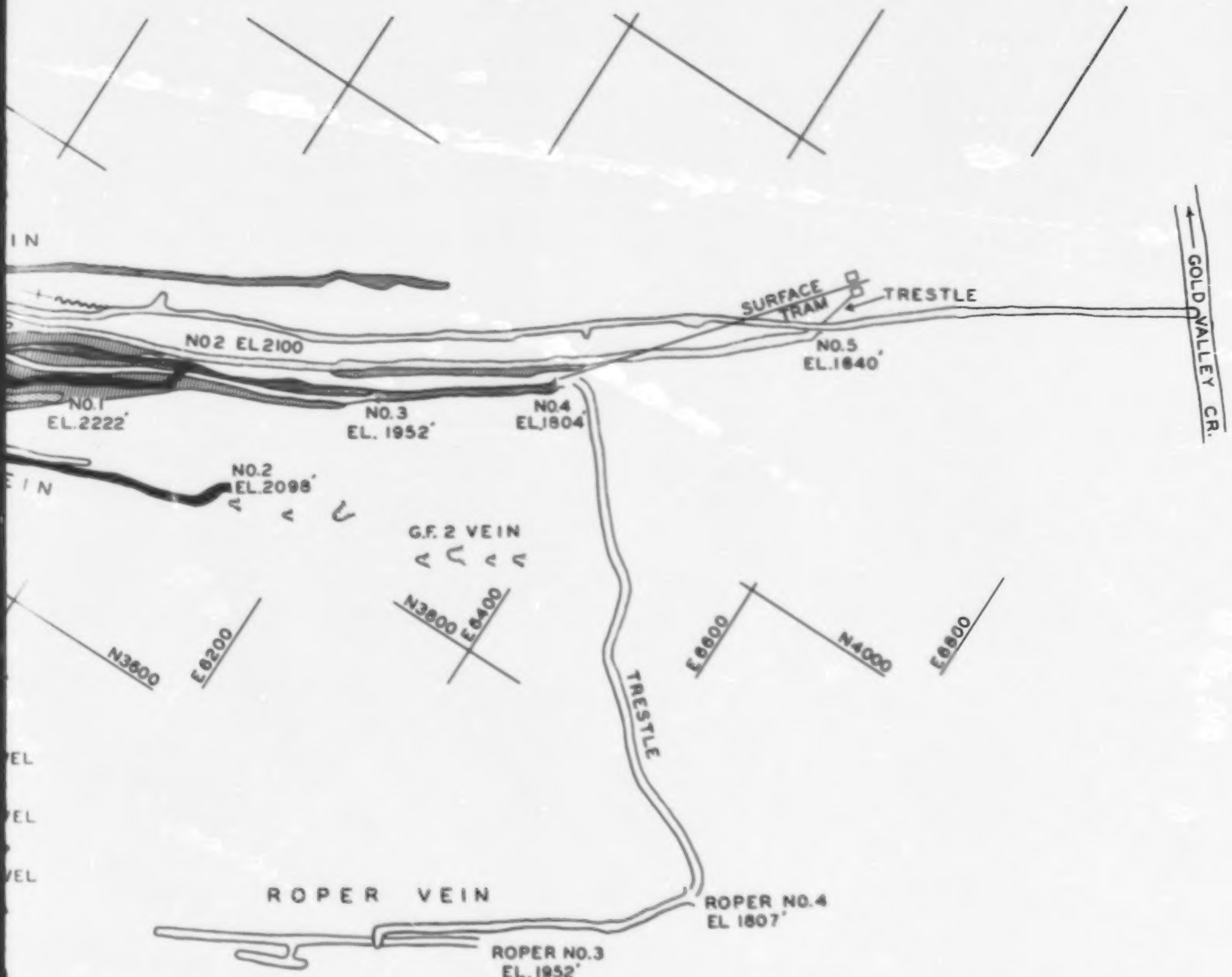
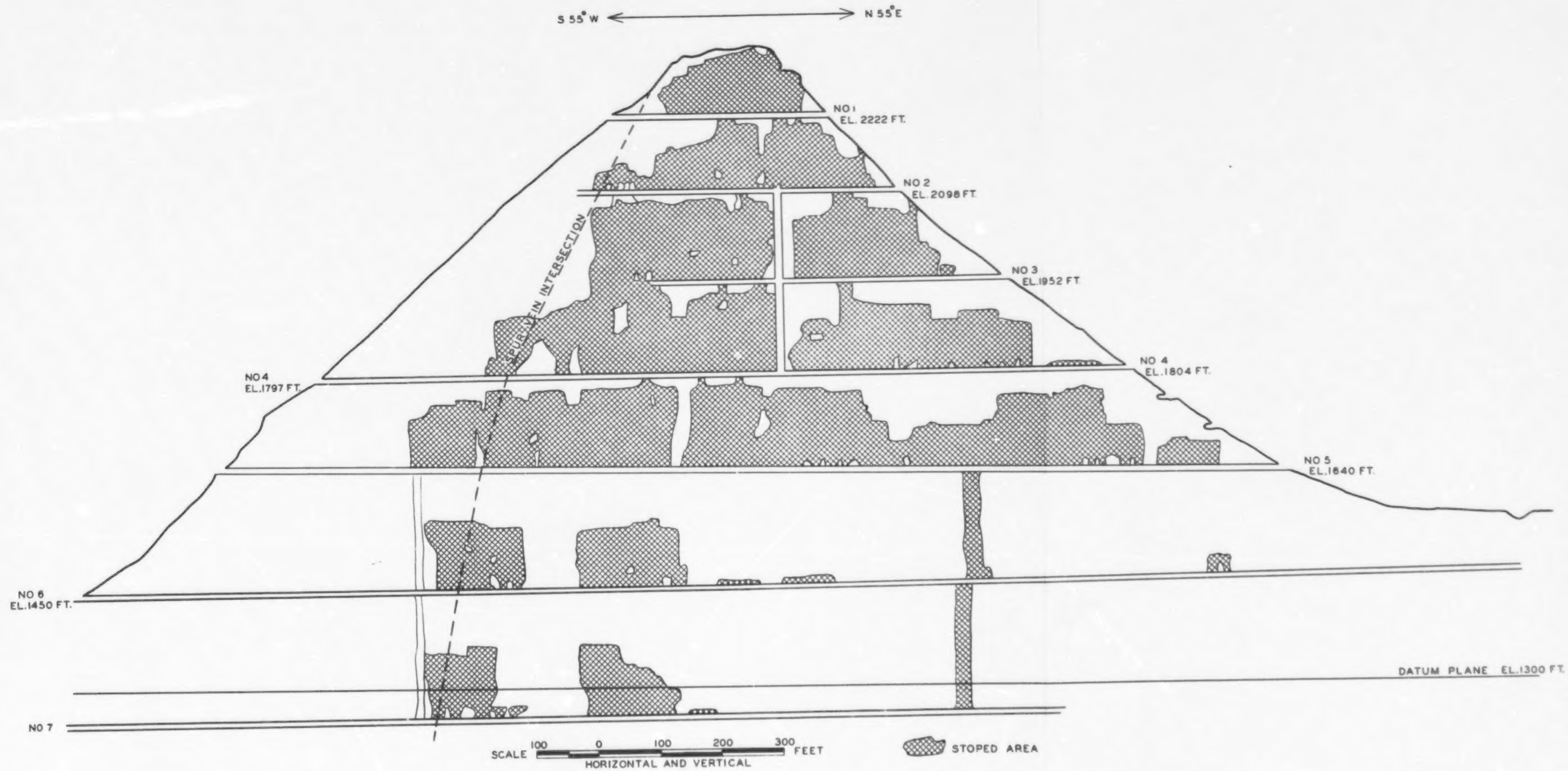

GOLDFIELD VEIN
TO MILL
NO.7
EL.1238'
TO MILL
AERIAL TRAM
ORE BIN
NO.5
EL.1652
NO.6
EL.1450
NO.4
EL.1797
NO2 EL.2100
NO.1
EL.2222'
NO.3
EL. 1952'
NO.4
EL.1804'
SPUR VEIN
NO.2
EL.2098'
G.F. 2 VEIN
E4800
N2800
E5000
E5200
N3000
E5400
N3200
E5600
E5800
N3400
E6000
N3600
E6200
N3800
E6400
E6600
TRESTLE
DIABASE DYKE ON NO 7 LEVEL
"BIG FAULT" ON NOs. 6 & 7 LEVELS
STOPED AREA ABOVE DRIFT (VEIN DIPS N.W.)
NO 1 LEVEL
NO 2 LEVEL
NO 3 LEVEL
NO 4 LEVEL
NO 5 LEVEL
NO 6 LEVEL
NO 7 LEVEL
ROPER VEIN
ROP
EL 1
ROPER NO.3
EL. 1952'
SCALE 100 0 100 200 FEET

FIG 22. SPUD VALLEY GOLD MINES LIMITED. PLAN OF LEVELS ON GOLDFIELD, SPUR, AND ROPER VEINS, SHOWING STOPED AREAS IN PLAN ON THE GOLDFIELD VEIN.

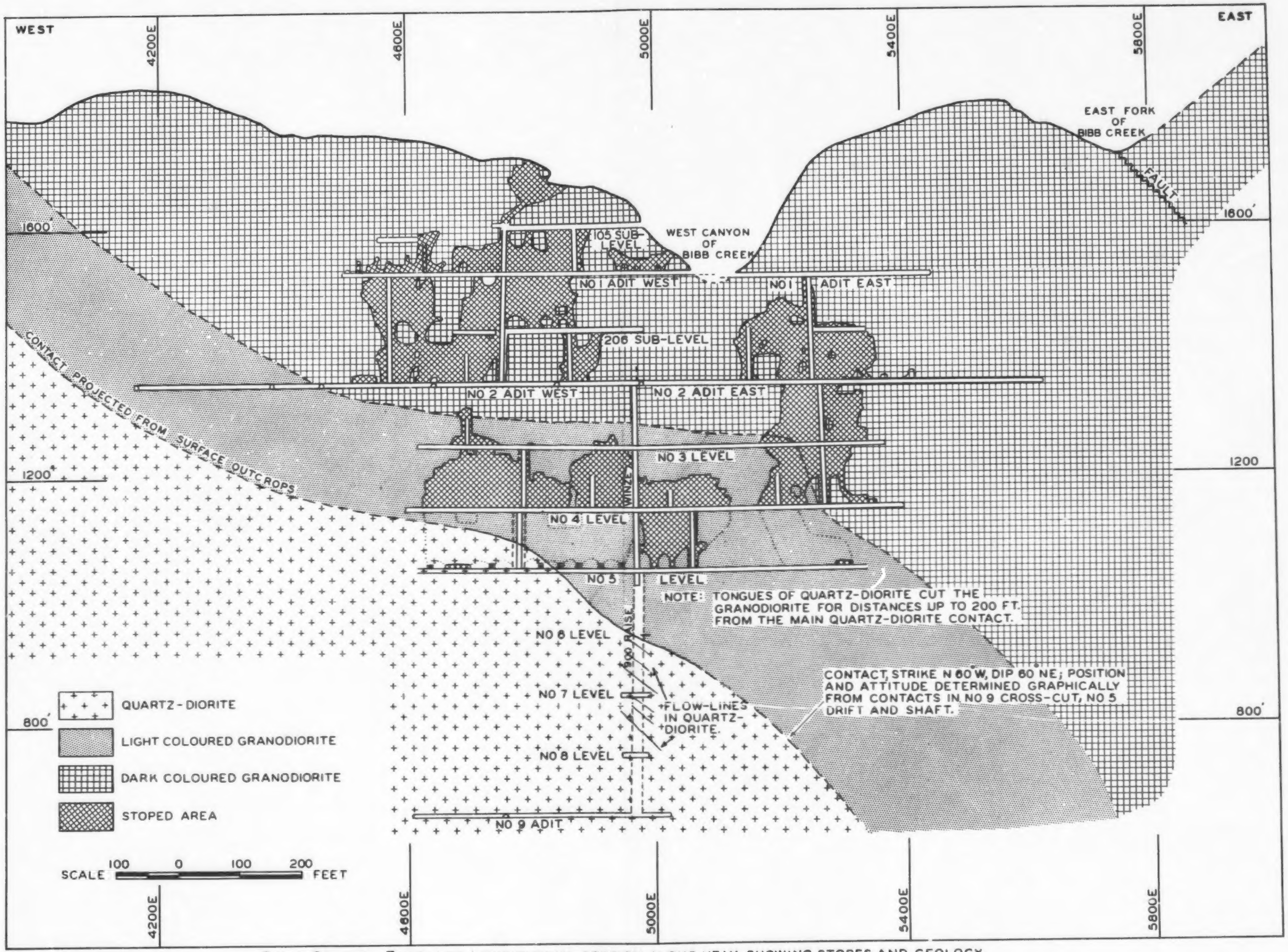

IN
SURFACE TRAM
TRESTLE
GOLD VALLEY CR.
NO2 EL.2100
NO.5 EL.1840'
NO.1 EL.2222'
NO.3 EL. 1952'
NO.4 EL.1804'
NO.2 EL.2098'
EIN
G.F. 2 VEIN
N3600
E6200
N3800
E6400
E6600
N4000
E6800
TRESTLE
EL
EL
VEL
ROPER VEIN
ROPER NO.4 EL 1807'
ROPER NO.3 EL. 1952'

SPUR, AND ROPER VEINS, SHOWING STOPED


S 55° W
N 55° E
NO 1
EL. 2222 FT.
NO 2
EL. 2098 FT.
NO 3
EL. 1952 FT.
SPUR VEIN INTERSECTION
NO 4
EL. 1804 FT.
NO 4
EL. 1797 FT.
NO 5
EL. 1640 FT.
NO 6
EL. 1450 FT.
DATUM PLANE EL. 1300 FT.
NO 7
SCALE 100 0 100 200 300 FEET
HORIZONTAL AND VERTICAL
STOPED AREA

SPUD VALLEY GOLD MINES LIMITED. LONGITUDINAL PROJECTION OF THE GOLDFIELD VEIN, SHOWING STOPED AREA.

FIG. 23



WEST
EAST
4200E
4600E
5000E
5400E
5800E
1600'
1200
800'
EAST FORK OF BIBB CREEK
FAULT
WEST CANYON OF BIBB CREEK
105 SUB-LEVEL
NO 1 ADIT WEST
NO 1 ADIT EAST
206 SUB-LEVEL
NO 2 ADIT WEST
NO 2 ADIT EAST
CONTACT PROJECTED FROM SURFACE OUTCROPS
NO 3 LEVEL
NO 4 LEVEL
WINZE
NO 5 LEVEL
NOTE: TONGUES OF QUARTZ-DIORITE CUT THE GRANODIORITE FOR DISTANCES UP TO 200 FT. FROM THE MAIN QUARTZ-DIORITE CONTACT.
NO 6 LEVEL
900 RAISE
CONTACT, STRIKE N 60 W, DIP 60 NE; POSITION AND ATTITUDE DETERMINED GRAPHICALLY FROM CONTACTS IN NO 9 CROSS-CUT, NO 5 DRIFT AND SHAFT.
NO 7 LEVEL
FLOW-LINES IN QUARTZ-DIORITE.
NO 8 LEVEL
NO 9 ADIT
QUARTZ-DIORITE
LIGHT COLOURED GRANODIORITE
DARK COLOURED GRANODIORITE
STOPED AREA
SCALE 100 0 100 200 FEET

FIG. 31. CENTRAL ZEBALLOS. LONGITUDINAL SECTION ALONG VEIN SHOWING STOPES AND GEOLOGY.

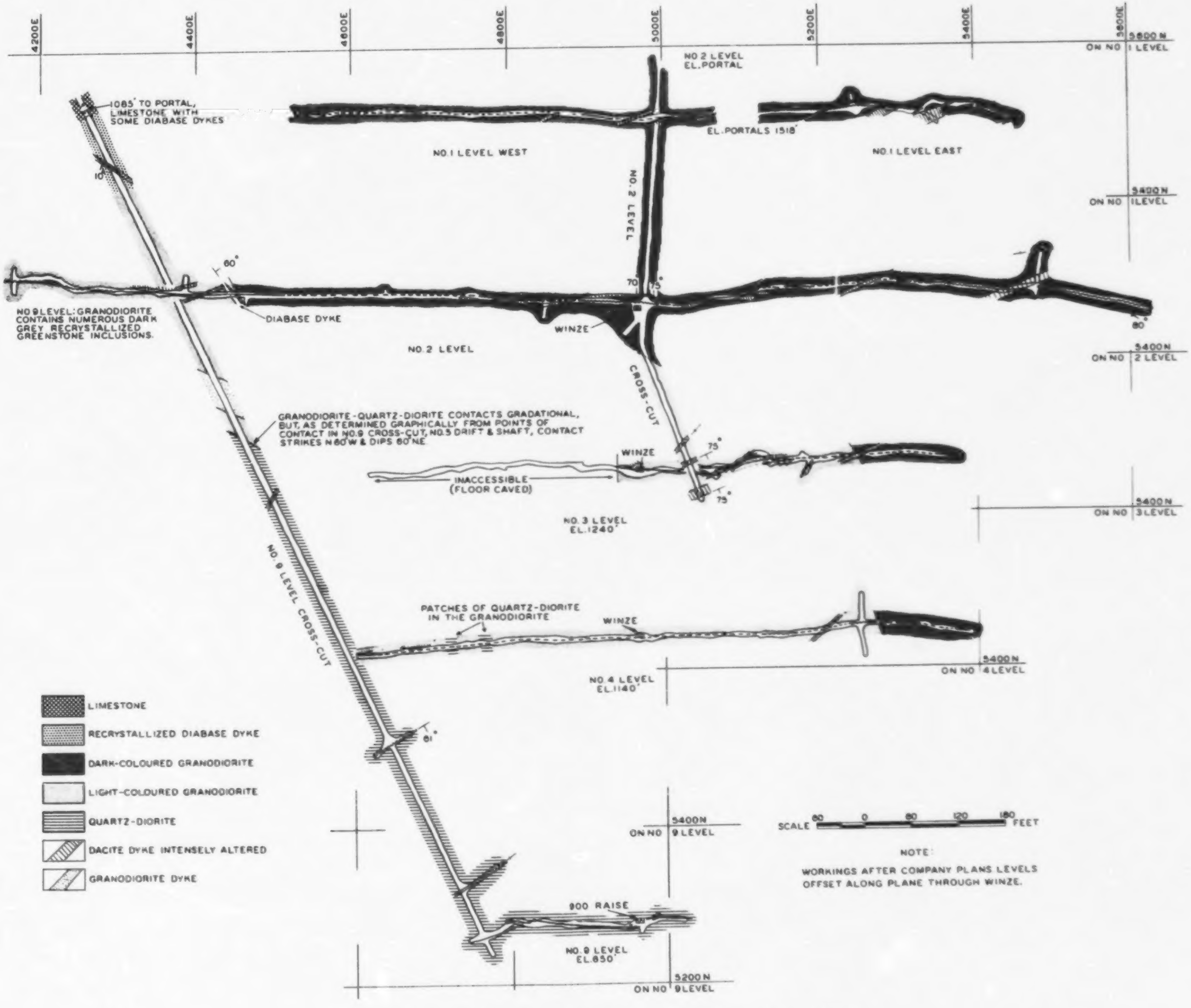
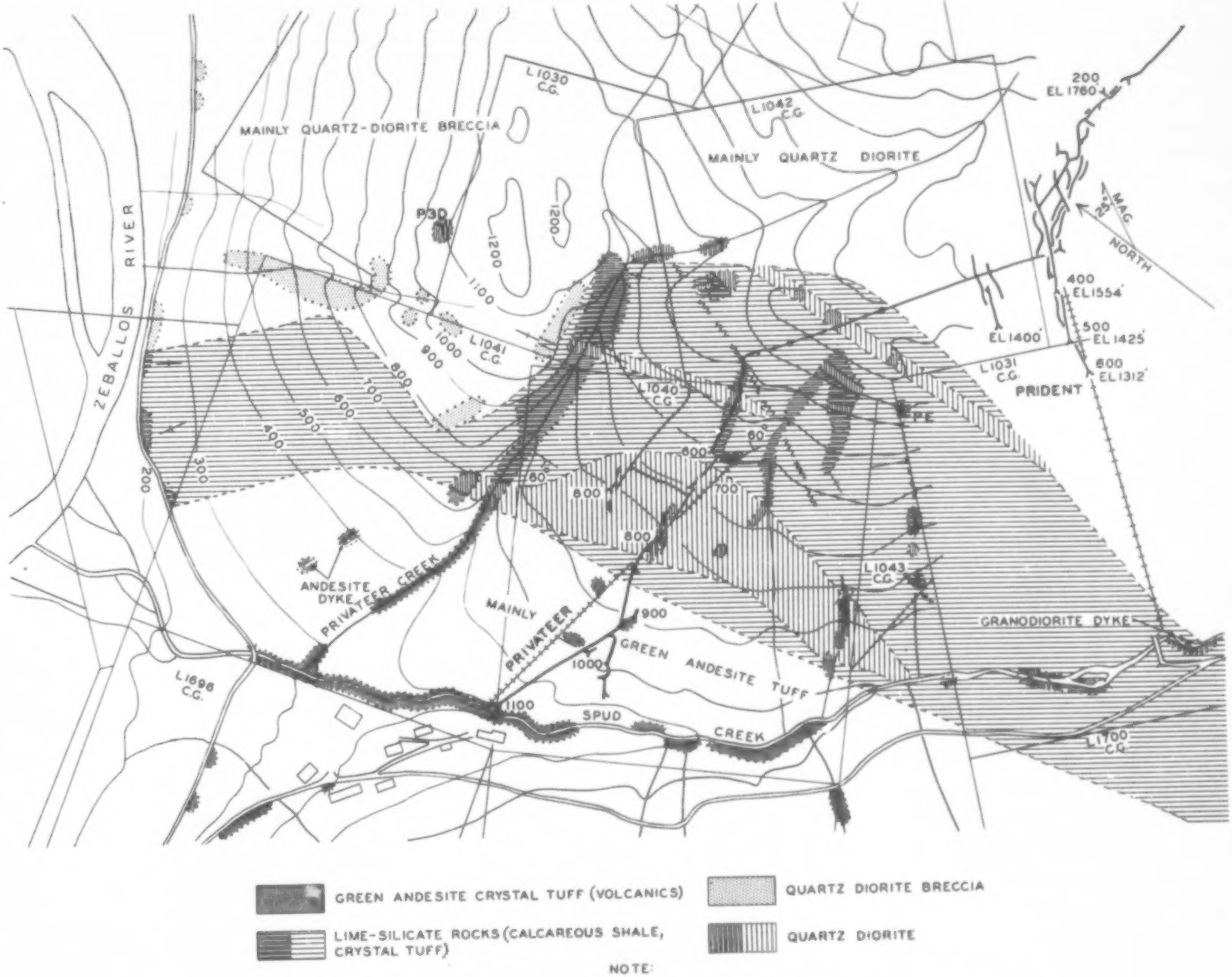

4200E
4400E
4600E
4800E
5000E
5200E
5400E
5800E
5600 N
ON NO 1 LEVEL
NO 2 LEVEL
EL. PORTAL
1085' TO PORTAL, LIMESTONE WITH SOME DIABASE DYKES
10°
NO.1 LEVEL WEST
EL. PORTALS 1518'
NO.1 LEVEL EAST
NO. 2 LEVEL
5400 N
ON NO 1LEVEL
60°
70
75°
80°
NO 9 LEVEL: GRANODIORITE CONTAINS NUMEROUS DARK GREY RECRYSTALLIZED GREENSTONE INCLUSIONS.
DIABASE DYKE
WINZE
NO.2 LEVEL
5400 N
ON NO 2 LEVEL
CROSS-CUT
GRANODIORITE-QUARTZ-DIORITE CONTACTS GRADATIONAL, BUT, AS DETERMINED GRAPHICALLY FROM POINTS OF CONTACT IN NO.9 CROSS-CUT, NO.5 DRIFT & SHAFT, CONTACT STRIKES N 60 W & DIPS 60 NE.
WINZE
75°
INACCESSIBLE (FLOOR CAVED)
75°
NO.3 LEVEL
EL.1240'
5400 N
ON NO 3 LEVEL
NO. 9 LEVEL CROSS-CUT
PATCHES OF QUARTZ-DIORITE IN THE GRANODIORITE
WINZE
5400 N
ON NO 4 LEVEL
NO.4 LEVEL
EL.1140'
61°
LIMESTONE
RECRYSTALLIZED DIABASE DYKE
DARK-COLOURED GRANODIORITE
LIGHT-COLOURED GRANODIORITE
QUARTZ-DIORITE
DACITE DYKE INTENSELY ALTERED
GRANODIORITE DYKE
5400 N
ON NO 9 LEVEL
SCALE 60 0 60 120 180 FEET
NOTE:
WORKINGS AFTER COMPANY PLANS LEVELS OFFSET ALONG PLANE THROUGH WINZE.
900 RAISE
NO.9 LEVEL
EL.850'
5200 N
ON NO 9 LEVEL

FIG. 30. CENTRAL ZEBALLOS MINE. PLAN OF LEVELS SHOWING GEOLOGY. NO.5 LEVEL NOT SHOWN.

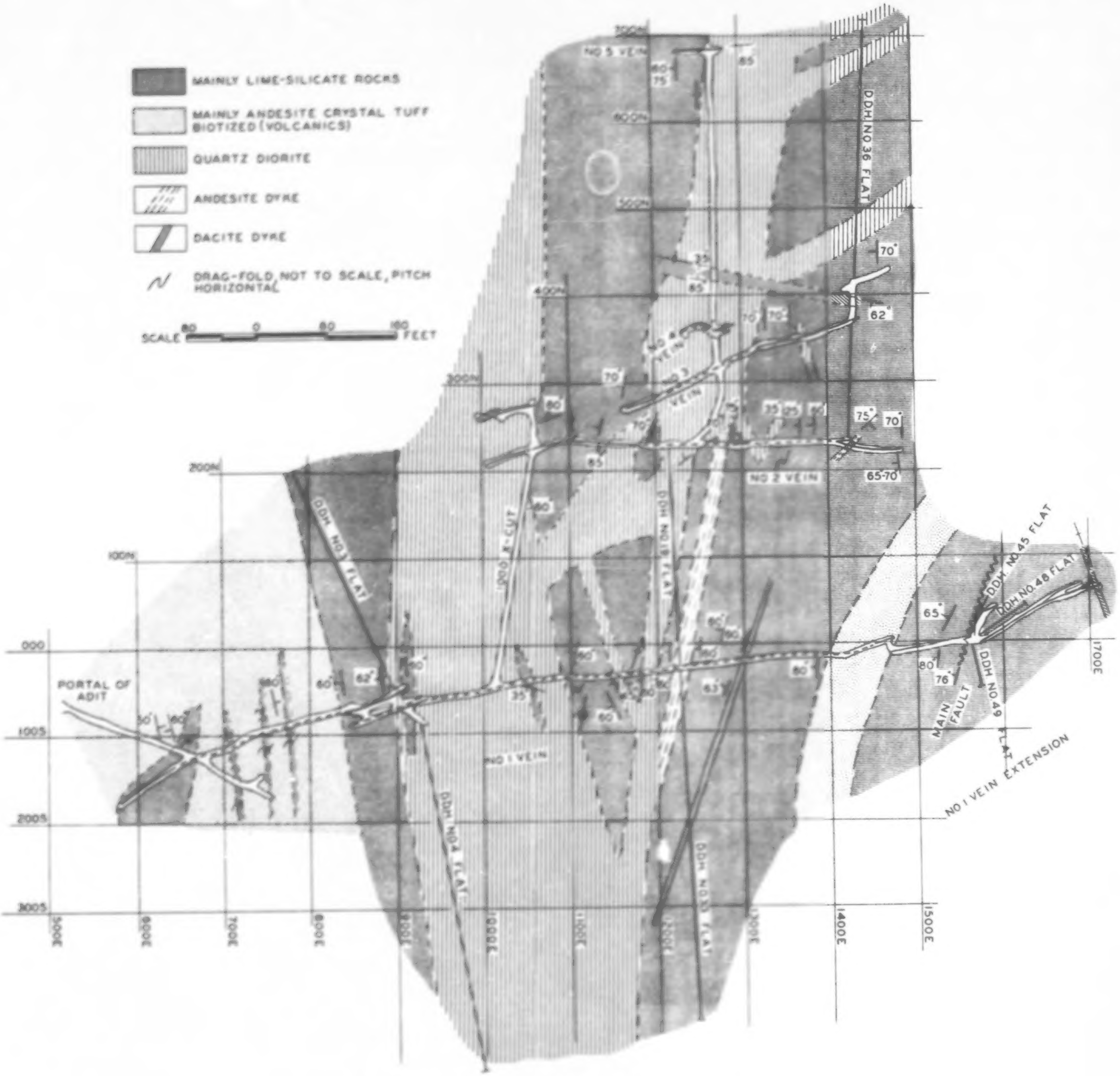

L1030 C.G.
L1042 C.G.
200 EL 1760'
MAINLY QUARTZ-DIORITE BRECCIA
MAINLY QUARTZ DIORITE
P3D
1200
1200
1100
1000
900
800
700
600
500
400
300
200
ZEBALLOS RIVER
MAG. NORTH
400 EL1554'
500 EL1425'
600 EL1312'
EL1400'
L1041 C.G.
L1040 C.G.
L1031 C.G.
PRIDENT
PE
60
80
600
700
800
800
ANDESITE DYKE
PRIVATEER CREEK
MAINLY
PRIVATEER
900
1000
GREEN ANDESITE TUFF
L1043 C.G.
GRANODIORITE DYKE
L1696 C.G.
1100
SPUD CREEK
L1700 C.G.
GREEN ANDESITE CRYSTAL TUFF (VOLCANICS)
QUARTZ DIORITE BRECCIA
LIME-SILICATE ROCKS (CALCAREOUS SHALE, CRYSTAL TUFF)
QUARTZ DIORITE

NOTE:

OUTCROPS ARE SHOWN BY DARK PATTERN; INFERRED EXTENSIONS ARE SHOWN BY THE SAME PATTERN, MORE WIDELY SPACED.

SCALE 300 0 300 600 FEET

FIG. 8. PRIVATEER. PROPERTY MAP SHOWING SURFACE GEOLOGY.



MAINLY LIME-SILICATE ROCKS
MAINLY ANDESITE CRYSTAL TUFF BIOTIZED (VOLCANICS)
QUARTZ DIORITE
ANDESITE DYKE
DACITE DYKE
DRAG-FOLD, NOT TO SCALE, PITCH HORIZONTAL
SCALE 80 0 80 160 FEET
NO 5 VEIN
NO 4 VEIN
NO 3 VEIN
NO 2 VEIN
NO 1 VEIN
NO 1 VEIN EXTENSION
PORTAL OF ADIT
1000 X-CUT
MAIN FAULT
DDH NO 36 FLAT
DDH NO 3 FLAT
DDH NO 4 FLAT
DDH NO 18 FLAT
DDH NO 33 FLAT
DDH NO 45 FLAT
DDH NO 48 FLAT
DDH NO 49 FLAT
700N
600N
500N
400N
300N
200N
100N
000
100S
200S
300S
500E
600E
700E
800E
900E
1000E
1100E
1200E
1300E
1400E
1500E
1700E

FIG 9 PRIVATEER. GEOLOGICAL PLAN OF THE 1000 LEVEL.